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JADS JT&E

Phase 3 and Phase 4 Verification and Validation Report for the End-to-End Test

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Contents

Appendices

Appendix A – Scientific Technical Information Report on Aircraft V&V Activities Report

Appendix B – Joint STARS Flight Test Cards

Appendix C – Apparent VDP Losses

Appendix D – Joint Advanced Distributed Simulation End-to-End Test Report of the Joint Surveillance Target Attack Radar System (U)

Appendix E – Acronyms and Definitions

List of Figures

List of Tables

1. Scope

This report provides the results of the verification and validation (V&V) tasks performed during Phase 3 and Phase 4 of the End-To-End (ETE) Test.

1.1 Purpose

This report details the results of executing the V&V requirements listed within the *ETE Test Activity Plan Appendix C: Verification and Validation Plan for the ETE Test* and the *Phase 3 Verification and Validation Plan for the End-to-End Test*

1.2 Verification and Validation Tasks

The V&V tasks performed on 23 February and 13 March 1999 during Phase 3 were conducted on the T3 aircraft parked on the ramp and are described in the *Phase 3 Verification and Validation Plan for the End-to-End Test.* During this V&V effort it was determined that the performance of the satellite link could not be determined exactly until Phase 4 and the live flights. Additionally, since the radar could not be operated on the ground, it was impossible to determine if the radar processor simulator and integrator (RPSI) interfered with the radar performance. This necessitated the extension of the V&V into Phase 4 and the live flights. It was also decided that during the Phase 4 live flights, the best way to ensure the RPSI and associated interfaces functioned properly was to perform an abbreviated version of the Phase 3 V&V.

There were also two V&V tasks that were either not completed or were not resolved when the *Phase 2 Verification and Validation Report for the End-To-End Test* was published. The results of these tasks are included in Section 5.1. of this report.

1.3 V&V Process Models

Within this report reference is made to steps enumerated within the Distributed Interactive Simulation (DIS) Nine Step Process Model. This model is shown as Figure 1.

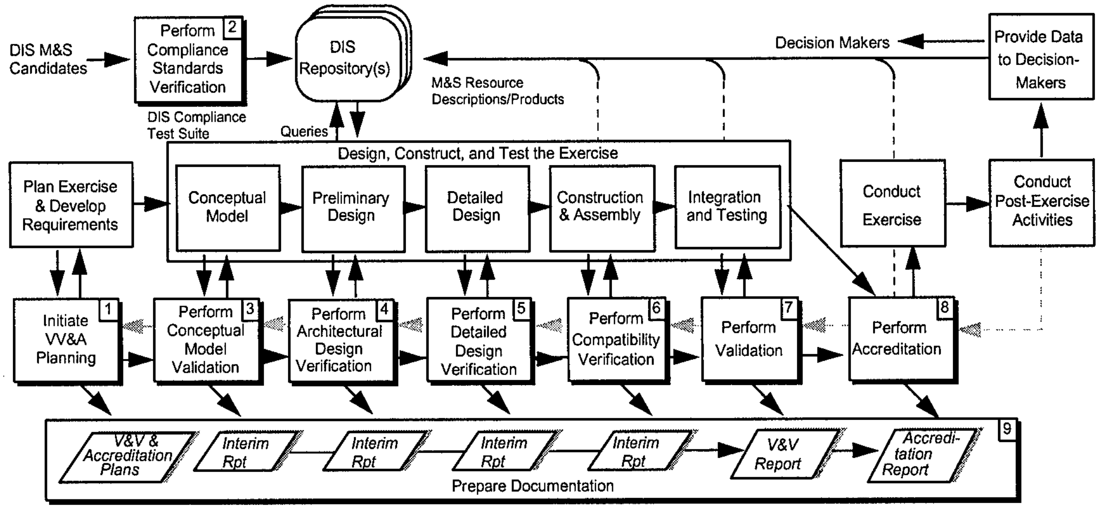


Figure 1. DIS Nine Step VV&A Process Model

The process model and its accompanying *Recommended Practice for Distributed Interactive Simulation -- Verification, Validation, and Accreditation* (Draft-4 November 1996) form the basis for the verification, validation and accreditation (VV&A) of the ETE Test synthetic environment (SE).

The DIS Nine Step Process Model was developed with a conventional, short-lived DIS exercise in mind, as opposed to a test of a major system, and presupposes a full complement of funds and personnel available at the beginning of the exercise development. This disparity was brought to the attention of the developers of the DIS Nine Step Process Model. It was decided that since the process model was a recommendation and intended for tailoring to the needs of the user, the model would continue to be tied to the DIS exercise development and construction process contained within Institute of Electrical and Electronics Engineers (IEEE) Standard 1278.3.

If one tailors the DIS Nine Step Process Model to the joint test process, then the process model would appear as shown in Figure 2.

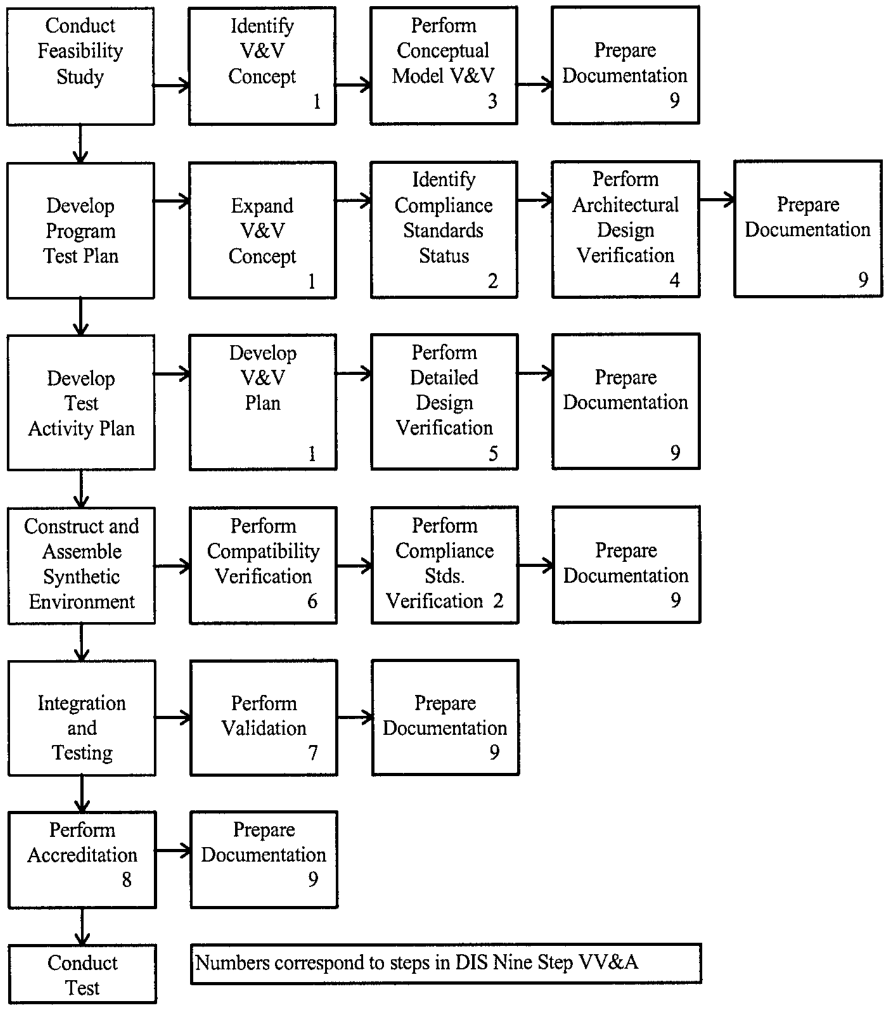


Figure 2. JADS ETE Test Process Model

In the Joint Advanced Distributed Simulation (JADS) ETE Test Process Model, test events which consist of the planning, construction and assembling of the SE, integration and testing of the SE, accreditation of the SE, and conduct of the test all proceed on the left side from top to bottom. The V&V events, to include documentation, proceed to the right for each test event.

2. Applicable Documents

2.1 Documents

ETE Test Activity Plan Appendix C: Verification and Validation Plan for the End-To-End (ETE) Test

Phase 3 Verification and Validation Plan for the End-to-End Test.

Department of Defense Verification, Validation and Accreditation (VV&A) Recommended Practices Guide, November 1996

Recommended Practice for Distributed Interactive Simulation -- Verification, Validation, and Accreditation, 4 November 1996

3. Verification and Validation Tools

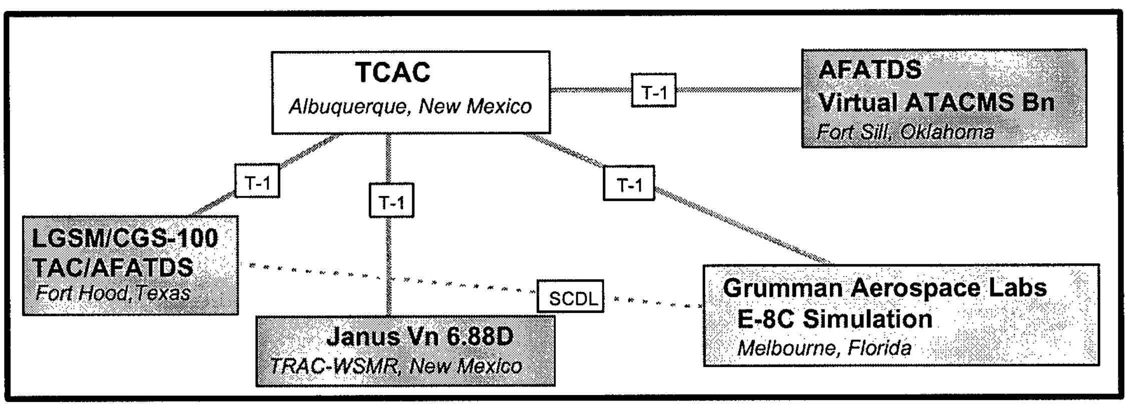
The following nonstandard software were used in the ETE Test Phase 2 V&V:

JADS Toolbox
JADS Logger
U.S. Army Simulation, Training and Instrumentation Command (STRICOM) Logger

4. Phase 3 and Phase 4 Configuration

To better understand the V&V requirements and the reasons for repeating some of the V&V tasks during Phases 3 and 4 that were performed during Phase 2, it will be helpful to review the Phase 2 configuration and discuss the Phase 3 and 4 configurations.

The ETE synthetic environment accredited for use during the Phase 2 operational test (OT) is shown in Figure 3.

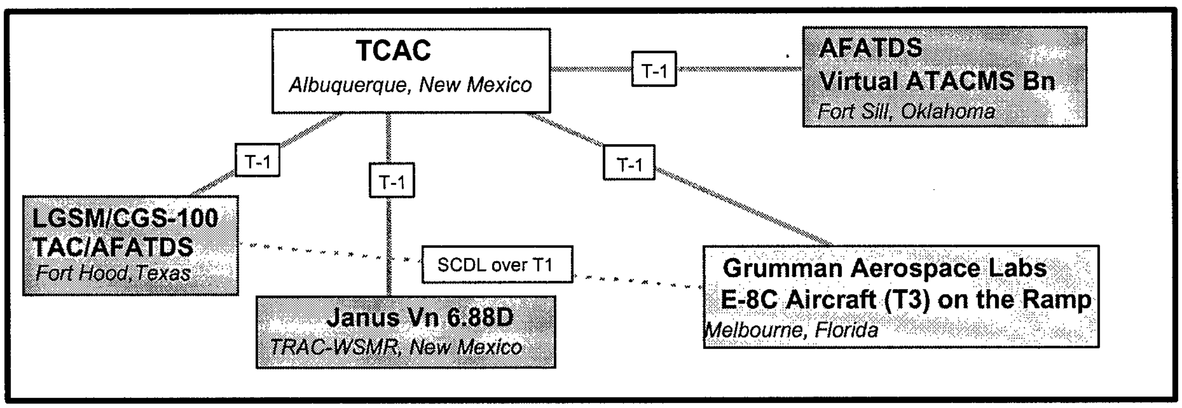


AFATDS = Advanced Field Artillery Tactical Data System
Bn = battalion
Janus = an interactive, computer-based simulation of combat operations
SCDL = surveillance control data link
T-1 = digital carrier used to transmit a formatted digital signal at 1.544 megabits per second
TAC = target analysis cell
TRAC = U.S. Army Training and Doctrine Command Analysis Center
ATACMS = Army Tactical Missile System
CGS = common ground station
LGSM = light ground station module
TCAC = Test Control and Analysis Center
WSMR = White Sands Missile Range, New Mexico

Figure 3. ETE Test Phase 2 Synthetic Environment

As can be seen, the simulation of the E-8C (the Virtual Surveillance Target Attack Radar System or VSTARS) was carried out within the Northrop Grumman Aerospace Labs located at Melbourne, Florida.

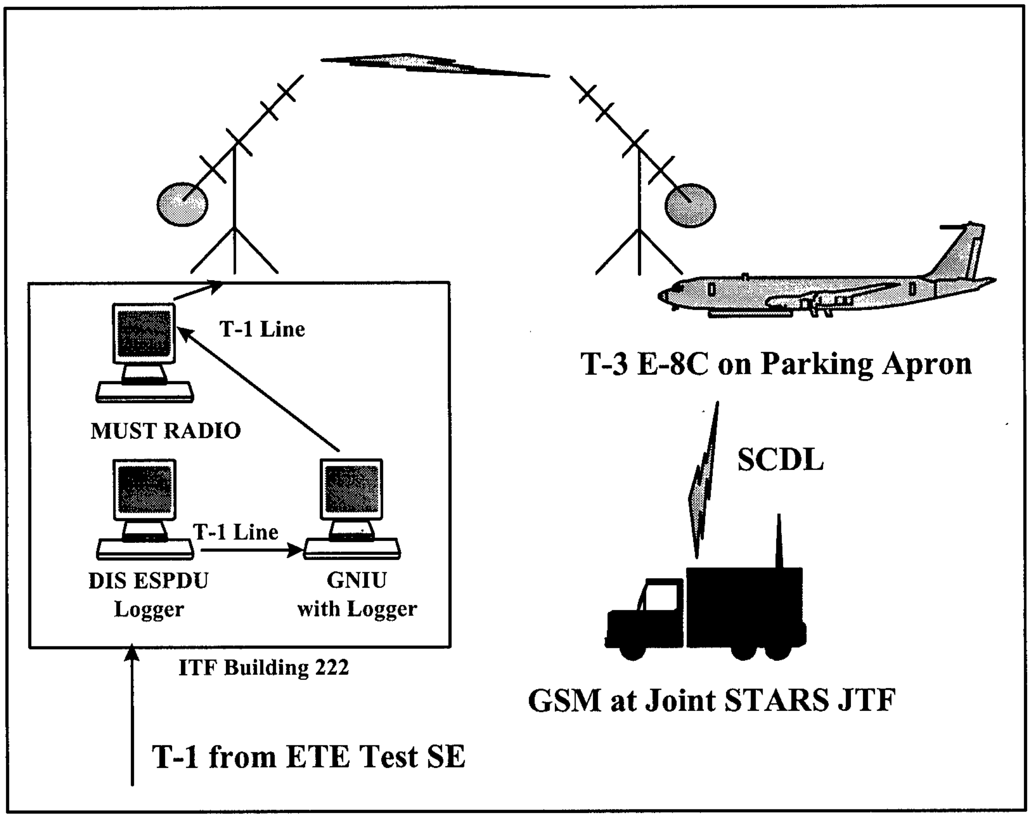
Phase 3 involved moving the RPSI and the air network interface unit (ANIU) onto the T3 E-8C located at Melbourne. The ground network interface unit (GNIU) remained within the laboratory and was connected to a satellite transceiver. The entity state protocol data units (ESPDU) were processed by the GNIU and converted to VSTARS data packets (VDP) that were than transmitted via satellite to the ANIU using the E-8C's satellite transceiver. The RPSI used these data to generate virtual radar reports on board the aircraft. The Phase 3 configuration is shown in Figure 4.



AFATDS = Advanced Field Artillery Tactical Data System
ATACMS = Army Tactical Missile System
Bn = battalion
CGS = common ground station
Janus = an interactive, computer-based simulation of combat operations
LGSM = light ground station module
SCDL = surveillance control data link
T-1 = digital carrier used to transmit a formatted digital signal at 1.544 megabits per second
TAC = target analysis cell
TCAC = Test Control and Analysis Center
TRAC = U.S. Army Training and Doctrine Command Analysis Center
WSMR = White Sands Missile Range, New Mexico

Figure 4. ETE Test Phase 3 Synthetic Environment

A detailed view of the Northrop Grumman labs and the E-8C aircraft configuration used during the V&V is shown in Figure 5.



GSM = ground station module JTF = joint test force SCDL = surveillance control data link
T-1 = digital carrier used to transmit a formatted digital signal at 1.544 megabits per second

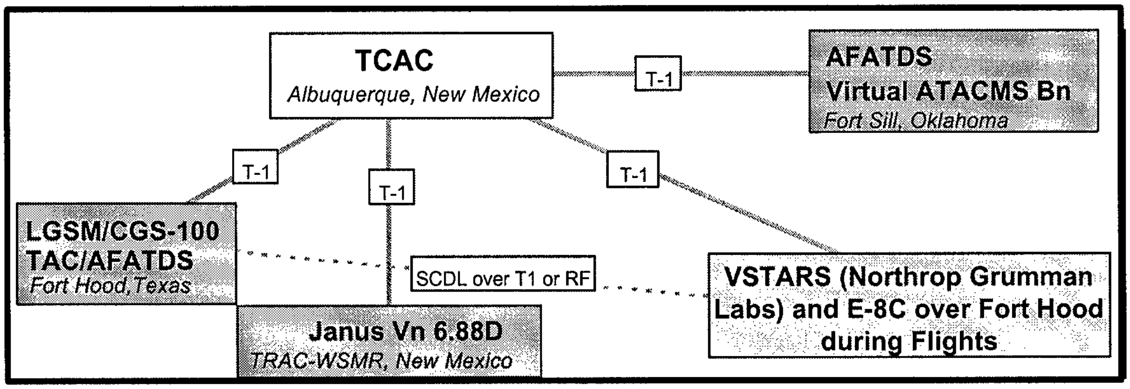
Figure 5. Phase 3 Melbourne Site Configuration

There were three issues that arose during the Phase 3 V&V. The first issue was that the radar could not be operated while the aircraft was on the ground. All V&V was conducted with the radar under a dummy load. As a result, live radar reports consisted entirely of noise and it could not be ascertained whether the RPSI interfered with the normal operation of the radar.

The second issue was also a result of the aircraft sitting on the ground. The navigation simulation used in the laboratory during Phase 2 had to be used on the parked aircraft in order to fool the radar simulation into thinking that it was flying. Therefore, it was not possible to verify that the aircraft navigation system could provide navigation information to the RPSI during flight.

The last issue involved the satellite transmission. During Phase 3, once link was established, it was maintained for the duration of the test event barring equipment failure. This was because both antennas were stationary throughout the duration of the test. During an actual flight, however, the antenna located on the aircraft would continuously change its orientation to the satellite, especially during turns. The possibility existed for data dropout to occur during a flight because of an unfavorable orientation of the antenna.

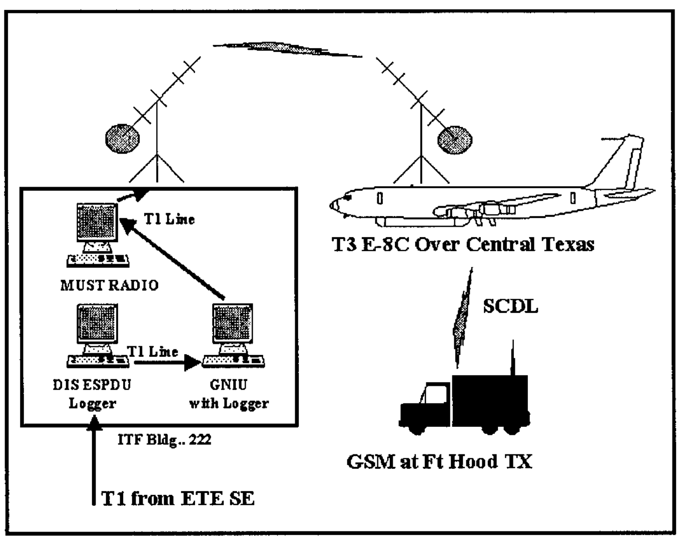
These three issues necessitated the extension of the V&V into the Phase 4 live flights. The Phase 4 synthetic environment is shown in Figure 6.



AFATDS = Advanced Field Artillery Tactical Data System
Bn = battalion
Janus = an interactive, computer-based simulation of combat operations
RF = radio frequency
T-1 = digital carrier used to transmit a formatted digital signal at 1.544 megabits per second
TAC = target analysis cell
TRAC = U.S. Army Training and Doctrine Command Analysis Center
ATACMS = Army Tactical Missile System
CGS = common ground station
LGSM = light ground station module
SCDL = surveillance control data link
TCAC = Test Control and Analysis Center
WSMR = White Sands Missile Range, New Mexico

Figure 6. ETE Test Phase 4 Synthetic Environment

A detailed depiction of the Melbourne, Florida, to aircraft over Fort Hood, Texas, to LGSM configuration is shown in Figure 7.



GSM = ground station module
SCDL = surveillance control data link
T-1 = digital carrier used to transmit a formatted digital signal at 1.544 megabits per second

Figure 7. Live Flight Configuration

5. Verification and Validation Tasks

This section of the Phase 3 and Phase 4 V & V report states the verification and validation requirements and describes the results of investigating the unresolved tasks mentioned previously and the tasks identified in the *Phase 3 Verification and Validation Plan for the End-to-End Test.*

5.1 Unresolved Tasks

5.1.1 Janus Vehicle Movement

Validate that J6K represents vehicle behavior to the degree detectable by the Joint Surveillance Target Attack Radar System (Joint STARS) operator(s). This capability will be judged based upon viewing vehicle movement upon the Joint STARS Advanced Technology Work Station (ATWS). Joint STARS operator subject matter experts (SMEs) will be used to evaluate these criteria.

5.1.1.1 Background

During the Phase 2 functionality and integration testing and V&V of the ETE Test synthetic environment, it was observed that the behavior of vehicles traveling in convoy was incorrect as observed by the Joint STARS operator(s). Investigation revealed that the behavior was portrayed correctly within Janus.

The anomaly consisted of portions of convoys missing turns and wandering off into the desert. The lost portion of the convoy would then jump back into formation after a period of time and resume normal movement.

5.1.1.2 Janus Modification

It was determined that this was caused by Janus not sending change of state ESPDUs in a timely fashion. Within Janus, or any other DIS-compliant simulation, ESPDUs are sent for any change of state (starting, stopping, turning, or changing speed beyond preset limits) in addition to the normal heartbeat ESPDUs for stationary entities. When Janus did not send the change of state ESPDUs in a timely fashion, VSTARS continued to move the vehicle in a straight line based upon the last received ESPDU.

The delay was caused by the method that Janus used to send ESPDUs. Janus cycles through the list of entities at a rate set by the operator and sends either a heartbeat ESPDU or a change of state ESPDU as appropriate. Because there were nearly 10,000 entities represented within Janus, the cyclic rate was set at a low enough value so that the protocol data unit (PDU) loss rate because of the routers would be acceptable. Consequently, it took Janus nearly 15 minutes to issue the 10,000 ESPDUs.

The solution was to modify the scenarios so that there was a one-hour period of no activity prior to the start of the six-hour vignette. During this period of inactivity, Janus would issue heartbeat ESPDUs giving the start-up location of each entity in the scenario. This start-up location would be stored by VSTARS, with the virtual radar in standby, and would be subsequently used to locate all nonmoving entities during the mission. Once the VSTARS database was loaded, the heartbeat would be turned off prior to the beginning of entity movement. This allowed adjustment of the cyclic rate so that Janus would check the 10,000 entities every 10 seconds and issue only change of state ESPDUs. The virtual radar would be taken out of standby, and the test mission would begin once scenario movement commenced. This reduced the delay in sending the change of state ESPDUs and the anomaly was no longer detectable.

5.1.1.3 Data Transmission Reliability

As with many solutions, this one caused a problem of its own. The heartbeat ESPDU functions as insurance for the synthetic environment. If a change of state ESPDU is lost, the next heartbeat ESPDU will update the location of the entity. Without the heartbeat, the entity will drive on forever if a stop ESPDU is lost, never start up if a start ESPDU is lost, or not turn if a turn ESPDU is lost. Those vehicles that don't turn and don't start, however, will be updated when the next change of state ESPDU is received.

This problem rarely occurs, given the reliability of the wide area network. Measurements of lost ESPDUs during the laboratory Phase 4 tests averaged one percent with most of the losses occurring because of equipment malfunction. If a portion of the network was down because of equipment malfunction for an appreciable amount of time, the test was paused and the heartbeat was turned back on to reestablish the position of each entity. This resulted in lost test time, normally less than twenty minutes, but ensured that the radar reports presented to the operators were valid.

Use of the satellite communications (SATCOM) link during the Phase 4 live flights, however, aggravated this problem because of the occasionally lower reliability of the link and the added opportunity for data loss. Loss rates of 0.35%, 0.17%, and 10.59% were observed during the 19 March, 25 March, and 31 March live flights, respectively. These rates equate to an overall loss rate of 2.74% for the SATCOM link. The loss rates for the 19 and 25 March live flights were comparable to those of the network links, suggesting that the SATCOM link was highly reliable during these test dates. However, the high loss rate experienced on 31 March suggests that there may have been problems in passing data via the SATCOM link for this trial.

Analysis revealed two apparent causes for the data losses experienced by the SATCOM link. The first and most notable event that caused losses resulted from software crashes of the ground network interface unit. When the GNIU is inoperable and not passing data to the E-8C, the entities on board the E-8C will continue to dead reckon on their last received velocity. If an entity changes velocity during the GNIU outage, it will not be passed to the E-8C. There were some cases noted where entities stopped in the Janus vignette during a GNIU outage, and consequently those entities on the E-8C were

continued on their last course and speed for the remainder of the vignette.

It was further observed that other entities that changed state during GNIU outages continued on the last course and speed until they received the next change of state from the Janus vignette. These entities, which appeared to miss turns during the outages, "snapped" back when the next ESPDU from the vignette was received. Although the GNIU outages were not frequent or lengthy, they resulted in the most notable wandering if they occurred during heavy activity (change of state) within the Janus vignettes.

The second cause was loss of data transmitted to the aircraft from the GNIU. The apparent losses varied from one lost data packet to 850 lost during a single occurrence. The vast majority of the losses were only several data packets at a time. It was not possible to determine the exact cause of the losses during post-test analysis. There does appear, however, to be a direct correlation between periods of high loss and aircraft turns at the ends of the orbit legs. This may be caused by a reduction in antenna efficiency caused by the roll induced in the aircraft during the turn.

There is also a possibility that the data were not lost but instead were never logged. All logging functions on the aircraft are performed by a general purpose computer that performs several primary radar functions. These radar functions have priority over the logging function and often result in data loss. This same phenomenon was observed when one of the test team's network data loggers was inadvertently used for compiling a program during the conduct of a test trial. Data were received at the node but were not logged.

Overall, the effect of the assorted data losses on the operators, both on the aircraft and on the ground, was minimal. The "lost" entities were indistinguishable from all the other entities and tended to add to the fog of battle normally present on the radar screen. They did lead to the misidentification of some areas as supply areas or assembly areas, but this was as much a result of improper procedures by the operators as it was the "lost" entities. The operators should have requested a synthetic aperture radar (SAR) of the suspected assembly or supply area in order to verify their identification of the area using moving target indicator (MTI) radar.

5.1.1.4 Validation

As a result of the described modification of Janus, it was specifically validated that Janus 6.88D represented vehicle behavior to the degree detectable by the Joint STARS as judged by Joint STARS operator SMEs viewing vehicle movement presented by the Joint STARS operator workstation.

5.1.2 Virtual Radar Performance

Verify that the MTI simulation meets radar performance measures as defined during developmental testing of the Joint STARS radar.

5.1.2.1 Background

During the conduct of the Phase 2 V&V, data were collected and provided to the Joint STARS Joint Test Force (JTF) for analysis to determine if the MTI radar simulation used in VSTARS met the Joint STARS radar performance specifications. Preliminary analysis of these data indicated that the simulation met, or was close to meeting, the performance specifications with the possible exception of the probability of false returns. The Joint STARS JTF requested, however, that an additional test case replicating an actual developmental test (DT) flight flown over Eglin Air Force Base, Florida, be analyzed prior to reporting on the performance of the simulations. Results of this additional test case were not available for the Phase 2 V&V report and are therefore presented herein.

5.1.2.2 Verification Results

The performance specifications for the Joint STARS radar are classified as are the results of the evaluation of the radar simulation. Therefore, the results will be addressed in qualitative terms as opposed to specific performance values.

Probability of detection (P_D)
- Met specification in high velocity range
- Did not meet specification (10% below) in low velocity range
- P_D consistently below typical production level performance

Probability of false alarm (P_{fr})
- P_{fr} did not meet specification; higher than specification and typical production level performance

Circular error probable (CEP)
- Met specification for all targets and radar modes
- Results comparable to current production level performance

The results given above were based on only one test point with several errors built into the scenario because of misunderstandings. They are preliminary at best. Further tuning and testing will be required before VSTARS is used for an actual operational test (OT) or DT.

Both P_D and P_{fr} are adjustable within VSTARS. Based upon comments received during the modified Turing test and the subsequent test rehearsal prior to the Phase 2 OT, the probability of false alarm was reduced to a level adjudged to be correct. Prior to a further use of VSTARS for testing, this measure will require further and more exhaustive testing.

Probability of detection was not adjusted prior to the Phase 4 OT. The 10% lower probability of detection in the low velocity range did not appear to have a major impact on the detection of convoys, primarily because the convoys portrayed in the test were normally larger than ten vehicles and moving at reasonable speeds.

Because this was the first time that a radar simulation had been checked to see if it met the actual system's specifications, there was a large amount of learning on the part of the Joint STARS JTF analysts, the JADS JTF, and Northrop Grumman as the test was conducted. This entire area, to include CEP error, must be reverified prior to any future use of VSTARS for testing.

5.2 Phase 3 and 4 Verification and Validation

5.2.1 Perform Compability Verification (Step 6)

5.2.1.1 Requirements

The compatibility verification will be performed by the ETE Test V&V team during Phase 3 of the ETE Test. The compatibility verification will ensure that the changes made during Phase 3, the movement of the RPSI to the aircraft and the linking of the air ANIU and the GNIU by SATCOM, are compatible with the ETE Test SE by ensuring:

- modeling and simulation (M&S) components exchange data and interact appropriately with each other;
- individual components correctly use the common data (e.g., terrain, weather) to generate their portion of the synthetic environment; and
- the overall implementation is adequate to address the exercise requirements.

This activity involves three major tasks: evaluate design versus implementation, evaluate compatibility and evaluate interface implementation.

Evaluate Design Versus Implementation. This task will determine if the design is sufficient to ensure the adequacy of the overall implementation by comparing the design as documented (e.g., conceptual model, component compliance profiles and fidelity characterizations) and the exercise configuration. The V&V team will participate in an exercise development walk-through and apply a series of checks to compare the physical configuration to the documented design. In addition, functional testing will be applied to assess performance of the synthetic environment over the course of the test.

Evaluate Compatibility. This task will determine if the individual components:

a) represent system performance as required for the exercise;
b) transfer information to and from the network without corruption;
c) share common perspectives of the virtual reality produced by the exercise; and
d) employ database elements, shared models and support systems appropriately.

Evaluate Interface Implementation. This task focuses on network performance needs, interface implementation issues, and identification of changes in the exercise configuration that could impact operation of the network. The V&V team will inspect the hardware configuration and review data collection and transfer between components to determine that the interface implementation is in accordance with interface

specifications. The V&V team will also evaluate the results of satellite transmission loading and latency tests for possible impacts on simulation results.

5.2.1.2 Results

Evaluate Design Versus Implementation. The evaluation was conducted during both Phase 3 and Phase 4. Initially, at the beginning of Phase 3 a design review was conducted between members of the ETE Team and engineers from Northrop Grumman. At this time the proposed configuration, to include intermediate test configurations, was compared to the documented design. Changes made were to add additional instrumentation and logging capability in order to characterize the satellite link's performance during Phase 4.

In addition, functional testing was conducted on all modified components of the synthetic environment. The results of this functional testing are contained within Appendix A: Scientific Technical Information Report on Aircraft V&V Activities Report. In summary, all components functioned as expected with one exception.

When a SAR image is requested in a mixed radar area, the requirements state that a virtual SAR will be presented to the operator. During the Phase 2 V&V, it was observed that this function was wrong (a real SAR was presented). This was easily corrected in the working copy of VSTARS but was never corrected in the configuration controlled master copy. When Phase 3 began, a fresh copy of VSTARS was taken from configuration control and modified to work on the aircraft (build JDS 07_006+). Once the build was completed, it was placed under configuration control prior to the conduct of the system integration tests (SITs) and the V&V.

When the V&V was conducted, it was observed that the Phase 2 problem, real SARs instead of virtual SARs in a mixed area, was present. Correction of the problem, though easy, would have required a new build and retesting prior to use. There was neither time to make a new build nor available aircraft test time to permit this.

The decision was made to proceed without correcting this problem in the build. The test cards to be used during the live flights were modified so that the mixed area would be located in an area that would preclude the need for a virtual SAR in support of the operational test.

Evaluate Compatibility. Compatibility was evaluated during the testing leading to the development of the build, during the formal V&V mentioned, and during the live flights in support of Phase 4.

The ETE Test Phase 3 migrated certain software components of VSTARS, specifically the ANIU and the RPSI from the laboratory Alpha workstations to the primary mission equipment on the T3 E-8C aircraft. In addition, the GNIU software was separated from VSTARS and migrated to an Alpha workstation collocated with a satellite transceiver.

Once the migration was completed, each component was tested in isolation and then tested as a part of the complete environment. Specifically, the network to GNIU link was tested verifying that the GNIU was issuing a VSTARS data packet for each PDU received. The GNIU to satellite transceiver to satellite transceiver to ANIU was also tested verifying that VSTARS data packets were received. Finally, the ANIU and RPSI were tested using primary mission equipment in the laboratory verifying that they processed the data and generated the appropriate radar reports. Once all components were shown to be working, the software was moved to the aircraft. The entire environment was then verified using PDUs generated at U.S. Army Training and Doctrine Command Analysis Center (TRAC), White Sands Missile Range (WSMR), New Mexico, sent to Northrop Grumman, and then sent via satellite to the aircraft.

The value of this task was proven when it was detected during the V&V that the VSTARS data packets were being corrupted because of a parsing problem associated with the satellite link. This problem was corrected prior to the live flights, and that portion of the V&V was conducted again just prior to the flight.

Another way to state the compatibility requirement is to ask if the synthetic environment, as well as its components, is working. For this reason, it was decided that the best way to make sure everything was working correctly during the flight was to repeat the V&V activities used prior to the flight. Appendix B: Joint STARS Flight Test Cards contains the flight test cards used to conduct the V&V activities during the flight. These activities are in addition to the operational test activities conducted during the flight.

In summary, the individual components represented system performance as required for the exercise; transferred information to and from the network without corruption; shared common perspectives of the virtual reality produced by the exercise; and employed database elements, shared models and support systems appropriately.

Evaluate Interface Implementation. The evaluation of the interface implementation focused primarily on the GNIU and ANIU and their associated satellite link. As mentioned above, an early part of Phase 3 involved verifying that these interfaces functioned properly. Once the parsing problem was corrected, the interfaces functioned properly throughout the remainder of the test. The separation of the GNIU, and its rehosting on a separate computer, however, did create some reliability problems. There were numerous crashes of GNIU software during the test. These crashes were caused by hardware failures and possible software unreliability. Future use of the separated GNIU should be preceded by thorough testing of the software on a reliable computer and modification of the software if required.

Some verification of the associated satellite link has already been discussed in the section of this report dealing with data loss through transmission problems. The section of this report dealing with SATCOM characterization and verification will discuss the satellite link in further detail.

5.2.2 Radar Processor Simulator and Integrator V&V

The radar processor simulator and integrator is the core of the radar simulation known as VSTARS. It, along with the ANIU, provides to the aircraft the ability to view both real and virtual radar reports.

The verification and testing of the RPSI on board the E-8C was conducted by Northrop Grumman and the JADS JTF on 23 February and 13 March 1999. Verification, validation and test tasks were performed by Northrop Grumman with JADS ETE Test V&V team oversight.

The results of the Northrop Grumman V&V are contained in Appendix A. Some of the results have been previously discussed in Section 5.2.1.2. of this report.

In addition, the Joint STARS JTF required that prior to any test flight a series of SITs be conducted using the software build (JDS 07_006+) that would be flown during the flight. The SITs ensured the ability to use the subsystems on board the aircraft (radar, advanced tactical workstations, communications, and surveillance control data link [SCDL]) and ensured that they were not compromised in any way by the software changes and additions made to the radar build. The SITs were conducted, concurrently with the Northrop Grumman V&V, using the T3 aircraft and an medium ground station module (MGSM).

The results from implementing the ETE Test Phase 3 V&V and the Joint STARS JTF SITs are detailed in Appendix A and are summarized as follows:

- Verification of the advanced distributed simulation (ADS)-enhanced E-8C aircraft
  - The following were verified during the V&V and SITs
    - JDS 07_006+ permitted all of the aircraft subsystems to function normally
    - JDS 07_006+ processed parameter data in the same format as Joint STARS
    - JDS 07_006+ permitted all of the installed operator workstation software to function without abnormal fault messages occurring
    - JDS 07_006+ received and integrated virtual data from the ADS environment
    - JDS 07_006+ operated in three modes: live only, mixed live and virtual, and virtual only using the standard Joint STARS MTI message format
    - The radar timeline was not impacted by the MTI simulation
  - The requirement that JDS 07_006+ display live SARs in live areas of interest and virtual SARs in both virtual and mixed areas of interest using the standard Joint STARS SAR message format was not completely met. The software build contained an error, previously observed and corrected in VSTARS, that resulted in live SARs displayed in a mixed area of interest (in which only virtual SARs should have been displayed).
  - There was a problem with corruption of the data packets when sent via the satellite link. This problem manifested itself by identifying nonmoving targets as moving targets. One of the programmers had found it necessary to add thirty-two bits to the VSTARS data packet in order to separate the GNIU and the ANIU.

The programmer working on the satellite link was not told this and continued to parse the data packets as 192-bit as opposed to 224-bit data packets. Once the error was found, it was corrected and that portion of the V&V was repeated prior to the Phase 4 flight tests.

- Verification of the SCDL
  - The SCDL was tested by the Joint STARS JTF during the conduct of the SITs on board the aircraft.
  - The aircraft was linked to both the SCDL laboratory at Northrop Grumman and to a light ground station module (LGSM) that belonged to the Joint STARS JTF. During this testing, it was verified that JDS 07_006+ could link to both the old SCDL format and the new SCDL format allowing its use with both ground station modules (GSMs) and common ground stations (CGSs).

- Validation of JDS 07_006+. The validation of JDS 07_006+ was performed by the Joint STARS JTF operators who performed the SITs and included several of the operators who took part in the Phase 2 validation of VSTARS. It also included several operators who had not previously seen ADS-enhanced radar.
  - All the operators were impressed with the performance of JDS 07_006+, and those that had previously tested VSTARS noticed no differences from the previously validated laboratory version. The operators that had not previously seen ADS-enhanced radar made the same comments as noted in the Phase 2 V&V report.

5.2.3 SATCOM Characterization and Verification

The partial characterization and verification of the SATCOM link between the GNIU and ANIU was conducted by Northrop Grumman and the JADS JTF on 23 February and 13 March 1999. At that time it was determined that a complete characterization and verification could not be conducted until the aircraft was in flight over Fort Hood, Texas, and receiving data from the GNIU.

The results of the characterization and verification of the SATCOM link conducted by Northrop Grumman are contained in Appendix A and are summarized as follows:

- Once correction was made for the VDP size, it was verified that the SATCOM link was able to pass uncorrupted scenario data from the GNIU to the ANIU.
- Maximum reliable transmission rate was characterized at 34 VDPs per second.

The above measurements were made in the following manner. The GNIU, in addition to performing its normal functions, had the ability to log each time-stamped VDP as it was sent to the satellite transceiver (Must Radio). The aircraft system had the ability to log all activity on the aircraft local area network (LAN). Once the VDP was received by the satellite transceiver, it was sent over the LAN to the ANIU for processing. This transaction was logged by one of the general purpose computers (GPC) on the aircraft.

This procedure contained several flaws. The first flaw was that the logging was done before and after the transceivers. This prevented the determination of where in the process the VDP was lost. It could be that the ground transceiver failed to transmit, or that the rate was too high and the satellite could not process, or that the air transceiver failed to receive.

The second flaw was with the LAN logger on board the aircraft. The time stamp associated with each VDP received and logged was the log time. The GPC used for logging was also one of the primary radar subsystem computers. It buffered all the LAN traffic and logged when it had time, often several seconds after the traffic was received. Also, when traffic was especially heavy, it could overflow its buffer and lose data. As a result of these flaws, there was a possibility that data would be reported as lost but in fact was received and processed, and the apparent latency was almost always exaggerated. This flaw was a result of the requirement to not alter the system under test. Adding a dedicated LAN logger is an obvious alteration.

The log files were used to attempt to characterize and verify the actual performance of the SATCOM link after the three operational test flights conducted as a part of Phase 4. The above discussion should aid in understanding the results of the characterization and verification.

5.2.3.1 Phase 4 Results

Two elements were investigated using the VDP log files collected on the flights. They were latency and VDP dropout or loss. Table 1 shows the apparent latency for the SATCOM link based upon the log times for each VDP.

Table 1. SATCOM Latency Data

Flight	Node A	Node B	Latency (seconds)		
			Minimum	Maximum	Mean
331-3 (19 Mar)	GNIU	ANIU (GPC 2)	1.58	41.68	12.08
333-3 (25 Mar)	GNIU	ANIU (GPC 2)	2.82	29.95	12.99
335-3 (31 Mar)	GNIU	ANIU (GPC 2)	2.06	85.57	12.60

It was obvious from the maximum times observed for all three flights that an appreciable amount of buffering was taking place, either at the SATCOM transmitter or at GPC 2 on board the aircraft. An analysis of the ESPDU stream used to generate the VDPs revealed that the maximum buffering that should occur at the SATCOM transmitter was on the order of three or four seconds. One can therefore deduce that the majority of the buffering was taking place at the logger on GPC 2. This was substantiated by the fact that no apparent latency was observable on the radar displays. The presence of latencies as small as 1.58 seconds would also indicate that this was probably close to the actual transmission latency and is close to theoretical transmission times. These values were most likely recorded during a period of minimum load on GPC 2.

Figure 8 is a plot of the apparent latency exhibited by each VDP during the 31 March flight. It was arrived at by comparing the time stamp when the VDP was sent to the satellite transmitter against the time stamp when logged by GPC 2.

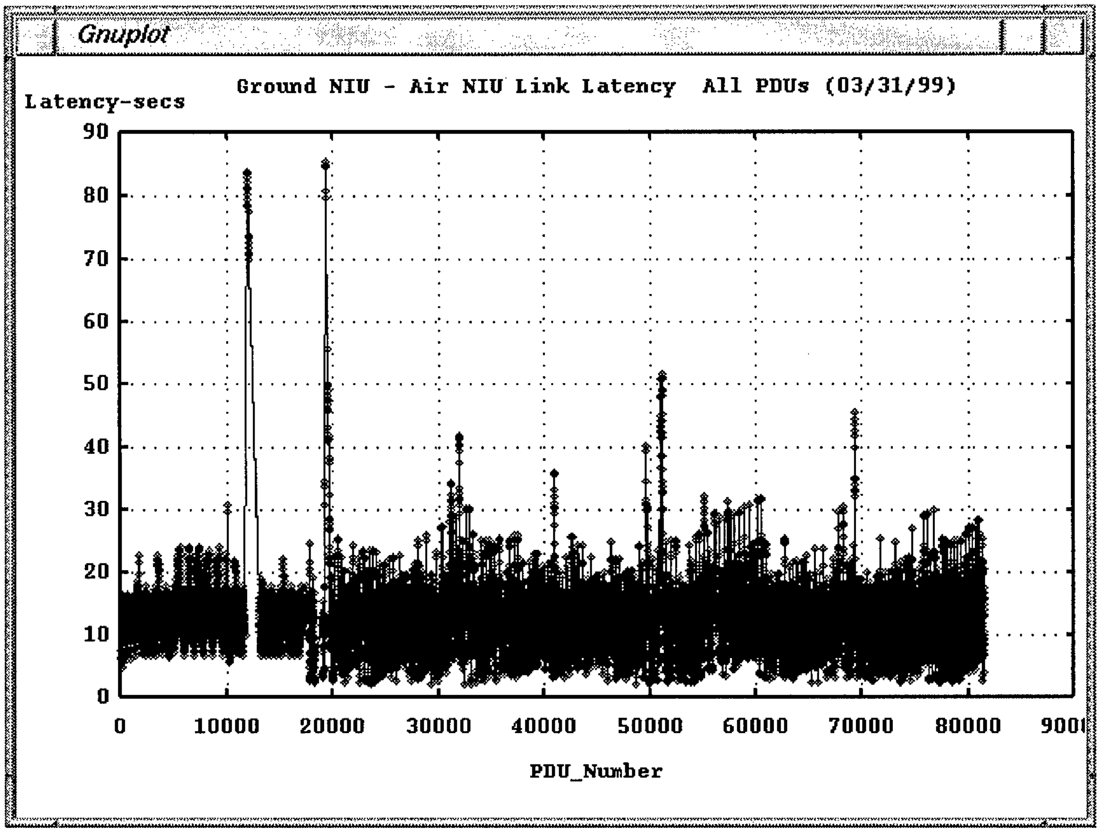


Figure 8. Apparent VDP Latency

As can be seen, there are underlying patterns to the data that are interrupted by events that appear to increase the recording delay. The first pattern, up to approximately VDP 12,000 was exhibited during the period when the heartbeat was turned on. The following pattern occurred during the time on station and represents the period when testing was occurring. Figure 9 represents a close up of a portion of Figure 8.

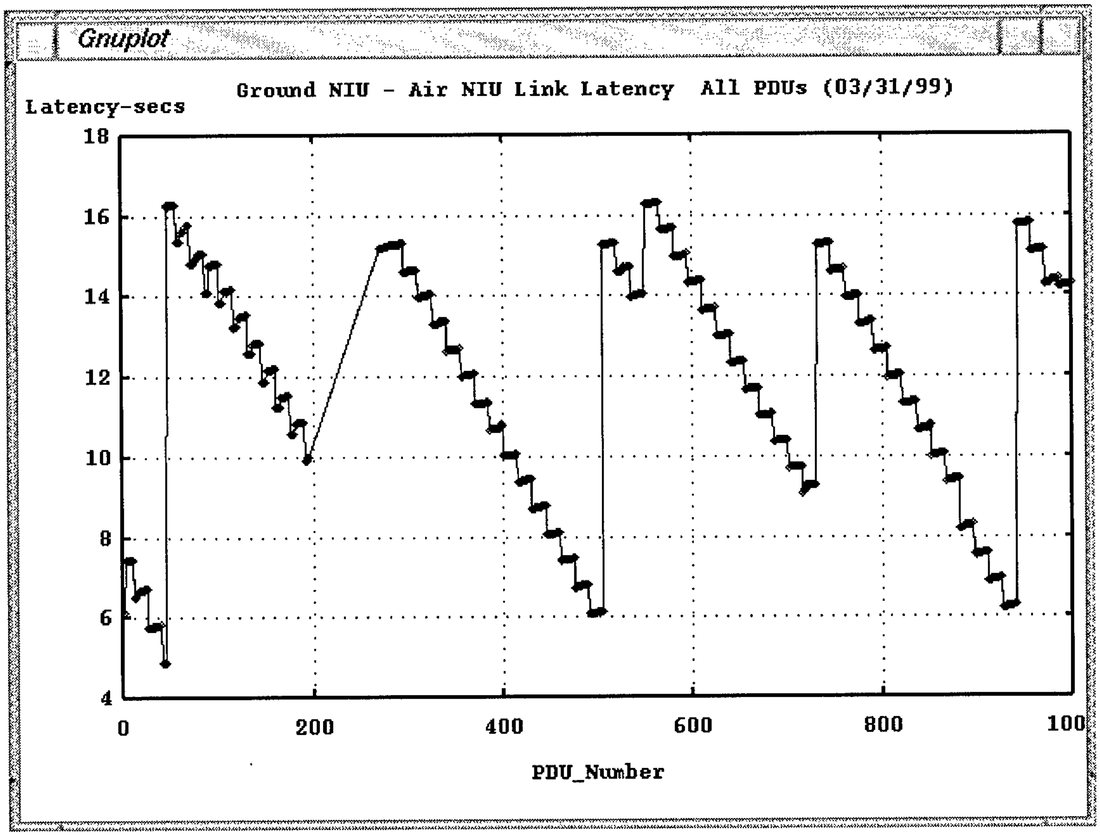


Figure 9. Apparent VDP Latency (Close Up)

The saw tooth appearance of the plot is indicative of a buffer operating. The near vertical rises in apparent latency are a result of the GPC stopping logging and performing another task(s). When the GPC returns to logging (the top of the saw tooth), it empties the buffer in segments. This is indicated by the serrations present on the descending latency. The missing VDPs (around 200 to 290) are most likely because of the buffer overflowing while the GPC was doing another task. The period represented in this figure is during the heartbeat phase when the ESPDU rate was relatively constant and well within the capacity of the satellite link.

The VDPs lost during the satellite transmission were arrived at using the same two log files. As previously discussed, there are two reasons for the apparent loss of VDPs. The two reasons are transmission loss and the just discussed failure to log the VDPs on the aircraft. Transmission loss can be caused by overloading the satellite link or by unfavorable antenna orientation during turns. Table 2 contains data from the 31 March flight that illustrate all of these losses. The complete set of data is contained in Appendix C: Apparent VDP Losses.

Table 2. VDPs Lost During 31 March Flight

Aircraft Action	Number Lost	Log_H/M/S	Probable Cause
Enroute to Ft Hood	75	16:12:11	Buffer Overflow
	1	16:13:45	
	5	16:13:46	
	27	16:13:46	Buffer Overflow
	117	16:13:48	Buffer Overflow
	1	16:13:49	
	1	16:15:45	
	227	16:16:16	Buffer Overflow
	1	16:16:24	
Break in Table			16 Occurrences of 2 VDPs lost
	2	16:29:19	
On Station	2	16:30:17	
	3	16:31:24	
	3	16:34:45	
	279	16:35:46	Buffer Overflow
	1	16:35:55	
	58	16:36:11	Buffer Overflow
	7	16:36:15	
	850	16:36:19	Buffer Overflow
Start of Movers	3	16:39:45	
	677	16:44:01	Buffer Overflow
	11	16:44:09	Buffer Overflow
	60	16:46:30	Buffer Overflow
	1	16:46:34	
	133	16:46:46	Buffer Overflow
	2	16:46:54	
Bad Turn 1648	103	16:49:25	Antenna Orientation
	2	16:49:28	
	113	16:56:06	Buffer Overflow
	1	16:56:15	
Good Turn 1705	1	17:09:40	
	1	17:11:39	

Normal transmission loss appears to be one or two VDPs on an infrequent basis. Buffer overflow occurs when GPC 2 is occupied performing radar tasks or logging other events, such as a SAR. Good turns occur at the end of the orbit that improves the antenna's orientation with respect to the satellite. Bad turns occur when the antenna is banked away from the satellite.

The total number of VDPs not logged for the three test flights is shown in Table 3.

Table 3. VDPs Not Logged

Flight	VDPs Transmitted	VDPs Logged	Apparent Losses
19 March 1999	120,618	120,190	428 0.35%
25 March 1999	130,025	129,798	227 0.17%
31 March 1999	86,787	77,595	9,192 10.59%

Despite the problems previously discussed, it is interesting to note that the apparent losses during the first two flights are insignificant. The last flight failed to log a significant number of VDPs, however, the loss of 4804 VDPs occurred after the aircraft had come off station and was in the process of shutting down various processes. In addition, 1694 VDPs were not logged before the aircraft arrived on station. The remaining 4376 VDPs were not logged during the flight because of buffer overflow or transmission loss.

Large groups or numbers of entities were never observed wandering off during the last flight. Given that Table 2 shows hundreds of VDPs not logged during single instances, it would appear that the majority of the VDPs were not logged because of buffer overflow.

5.2.3.2 Conclusions

The procedures used in an attempt to characterize and V&V the SATCOM link during the actual test flights were flawed at best and useless at worst. Dedicated, time-synchronized loggers will be required before the link can be fully characterized, verified, and validated.

Observation of all three flights by trained observers familiar with both real and virtual radar products revealed no apparent ill effects because of the use of the SATCOM link. The few entities, out of 10000, that did behave abnormally were either not noticed or, at worst, helped add realism by further contributing to the fog of war. Only one instance of a group of vehicles wandering off, discovered during post-test playback of data, was reported.

The use of the SATCOM link appears to be a feasible method for transmitting scenario data to the E-8C during flight, if the data flow can be restrained to remain within bandwidth limitations.

5.2.4 Perform Validation of Phase 3 and 4 ETE Synthetic Environment (Step 7)

The validation of the Phase 3 and 4 ETE SE was performed by the ETE Test V&V team assisted by Northrop Grumman and the Joint STARS JTF during the period 8 February to 31 March 1999.

The validation of the Phase 3 and 4 ETE Test SE was intended to ensure that the SE had not been noticeably altered as a result of the movement of the RPSI to the E-8C. The requirements for the SE remained the same as when validated during Phase 2 of the ETE Test.

This activity consists of four basic tasks: establish context for validation activities, evaluate configuration interoperability, perform effectiveness evaluation and evaluate test results.

5.2.4.1 Procedures

Establish Context for Validation Activities. This validation task was performed in preparation for the Phase 3 and 4 V&V. The scope of the validation effort is specified by the Phase 3 V&V plan. No new acceptability criteria were identified and potential shortcomings and limitations of the SE were identified.

Evaluate Configuration Interoperability. This validation task consisted of verifying the mapping of the individual components of the SE to the detailed design and validating that the individual components performed as required by the design.

Perform Effectiveness Evaluation. This validation task was a follow-on to the previous task. Once it was ascertained that the individual components performed as required, their effectiveness was ascertained by tracing exercise performance data to the acceptability criteria and evaluating the data for accuracy, sufficiency, and appropriateness.

Evaluate Test Results. This validation task was also a follow-on to the previous task. After the effectiveness of the individual components was determined, the effectiveness of the overall SE was evaluated and compared to the real world represented by the SE.

5.2.4.2 Results

The individual components were mapped to the detailed design, and it was verified that the mapping conformed to the detailed design with no changes. Validation of performance and effectiveness was accomplished in a stepwise manner.

The validation approach focused on validating that the changes made during Phase 3 did not alter the validity of the ETE Test synthetic environment as measured during the Phase 2 V&V. The changes made were represented within build JDS 07_006+.

Once it was ascertained that build JDS 07_006+ appeared to be functioning correctly, it was validated by the Joint STARS JTF and Northrop Grumman personnel executing the required SITs and the Phase 3 and 4 validation.

The Joint STARS JTF required that prior to any test flight a series of SITs be conducted using the software build that would be flown during the flight. The SITs ensured the ability to use the subsystems on board the aircraft (radar, advanced tactical workstations,

communications, and SCDL) was not compromised in any way by the software changes and additions made to the radar build. The SITs were conducted using the T3 aircraft and an MGSM. Validation was conducted to ensure that the ADS-enhanced radar system met the validation requirements and acceptability criteria established by the ETE Test team.

- Phase 3 validation of JDS 07_006+. The validation of JDS 07_006+ was performed by the Joint STARS JTF operators who performed the SITs and included several of the operators who took part in the Phase 2 validation of VSTARS. It also included several operators who had not previously seen ADS-enhanced radar.
  - All the operators were impressed with the performance of JDS 07_006+, and those who had previously tested VSTARS noticed no differences from the previously validated laboratory version. The operators who had not previously seen ADS-enhanced radar made the same comments as noted in the Phase 2 V&V report.
- Phase 4 validation of JDS 07_006+. The validation of JDS 07_006+ was performed by onboard personnel during the three flights previously described. They consisted of ETE Test team personnel, Northrop Grumman personnel, and Joint STARS JTF operators. The validation tasks performed during the Phase 4 flights are enumerated within Appendix B.
  - Personnel on board the aircraft were impressed with the performance of JDS 07_006+, and those who had previously tested VSTARS noticed no differences from the previously validated laboratory version. The operators whot had not previously seen ADS-enhanced radar made the same comments as noted in the Phase 2 V&V report.
  - There was no observable modification to the synthetic environment as a result of using the SATCOM link.
  - The realism of the synthetic environment was greatly enhanced because of the frequent system under test (SUT) failures that occurred during the flights. All SUT subsystems exhibited normal behavior during the time that the synthetic environment was operating.

5.2.5 Verification of Joint STARS Radar Performance

One element of verification that is not normally considered is the verification that the actual SUT continues to meet specifications when it is augmented with an ADS environment. This is especially important in a system such as Joint STARS where the ADS augmentation resides within the same system software as the system, uses many of the same processes and data, and mixes system and virtual data to produce radar reports.

During the 25 March mission, instrumented vehicles were present at Fort Hood, along with radar reflector arrays and special test tools used by the Joint STARS JTF. Measurements were made of the installed radar's performance, both in SAR and MTI mode, simultaneously with the conduct of the JADS ETE ADS-augmented test. Following the flight, the data were reduced and the radar was found to have performed within specifications. Details are contained within Appendix D: Joint Advanced

Distributed Simulation End-to-End Test Report of the Joint Surveillance Target Attack Radar System.

The ADS augmentation of the E-8C aircraft, as implemented within build JDS 07_006+, had no observable effect, adverse or otherwise, on the performance of the radar subsystem on board the aircraft. Performance of the operation and control (O&C) subsystem was also unaffected by the ADS augmentation. The datalink subsystem was enhanced by build JDS 07_006+ in that the SCDL capabilities were enhanced. Build JDS 07_006+ enabled the E-8C to receive uplink messages using both the old message formats from the LGSM and the new message formats from the CGS.

6. Conclusion

This verification and validation report completes the V&V of the JADS ETE Test synthetic environment. In summary, the JADS ETE Test synthetic environment satisfied the requirements and acceptability criteria stated at the onset of the ETE Test.

With respect to VSTARS and its components, it is very important to realize that this V&V applies only to the specific Joint STARS builds used in the ETE Test. Modification of the builds to run on different hardware or integration of VSTARS and its components into a different build will require further V&V.

In addition, it is expected that another test using VSTARS would have different or additional requirements for its synthetic environment. This would require that additional V&V are conducted to ensure that the new synthetic environment meets the acceptability criteria for the test.

This is not to say that the additional V&V must be as extensive as that conducted for the ETE Test. Much of the work done for the ETE Test may be used to baseline the synthetic environment and its simulations, requiring only an abbreviated check to see if the environment or simulation is performing as expected. This was what was done during Phase 4, when the V&V procedures were run during the test trials, to verify that the synthetic environment was functioning properly.

Finally, it is recommended that prior to the use of VSTARS for developmental testing, additional verification be conducted to determine that the VSTARS radar simulations perform to the level experienced during current developmental test flights.

Appendix A
Scientific Technical Information Report
on
Aircraft V&V Activities Report (Final)

SCIENTIFIC TECHNICAL INFORMATION REPORT
ON AIRCRAFT V&V ACTIVITIES REPORT
(FINAL)

CONTRACT NO: F307602-96-C-0281
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REVISION RECORD			
REVISION	DATE	DESCRIPTION AND PAGE AFFECTED	APPROVAL
-	29 Mar 1999	Original Release	-

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

SCOPE

This document reports the results of the Joint Advanced Distributed Simulation (JADS) Verification and Validation (V&V) for Phase III and IV of the End to End Test. This report summarizes the V&V effort and presents the results generated during execution. Phase III of the contract consisted of migration of the software to the Prime Mission Equipment (PME) in both the laboratory and the E-8C aircraft. It also included development of a Radio Frequency (RF) Link Interface using SATCOM. The objective of the V&V was to determine how closely the software meets the acceptability criteria set forth in the JADS End-to-End (ETE) Verification and Validation Plan. To ensure that the software did not interfere with the normal operation of Joint STARS, System Integration Tests (SIT) previously developed for the TADIL-J Upgrade program were run. The results of the Phase III, V&V were used to determine if the software warranted accreditation for use within the JADS ETE Test, or would require further modification prior to use in flight.

The purpose of Phase IV testing was to support the JADS End-To-End (ETE) Joint Task Force (JTF) during operational testing activities. This task included 7 laboratory test days and 3 live flights. Northrop Grumman test responsibilities included the operation and monitoring of the Northrop Grumman simulation. An abbreviated version of the Phase III, V&V was run during the live flights to confirm that the modified software did not interfere with standard Joint STARS operation.

V&V SUMMARY

Phase III V&V and SIT

Phase III V&V was conducted on the T-3 aircraft, parked on the ramp, on 23 February and 13 March 1999. Prior to migration to the T-3, testing was accomplished on PME located in the Radar Testing Laboratory (RTL). Lab configuration is illustrated in Figure 0-1.

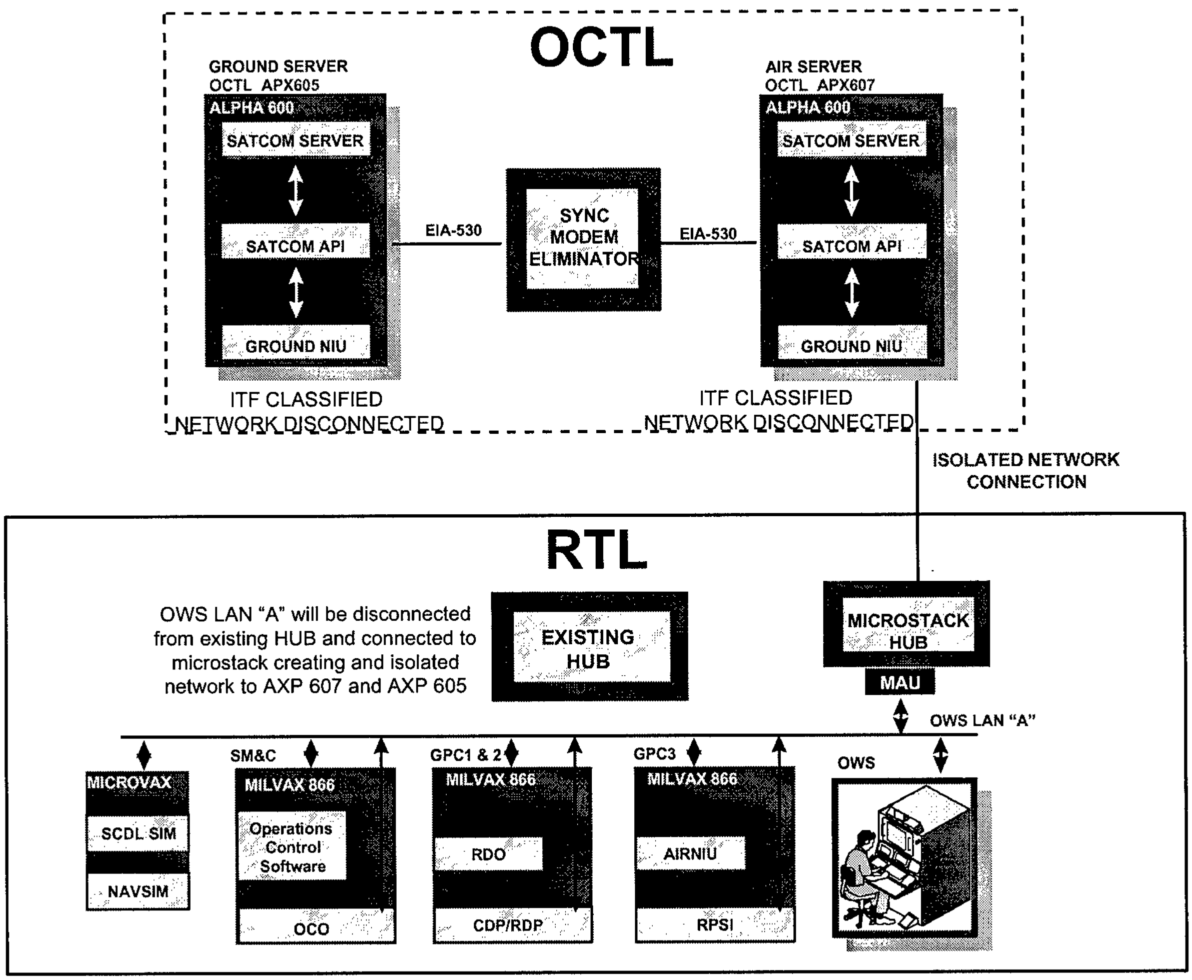

Figure 0-1. Laboratory Configuration for Testing

The V&V consisted of the moving target indictor (MTI), synthetic aperture radar (SAR), and SATCOM procedures as well as the SITs listed below:

1. Order of Battle-110-003
2. Comm-310-001
3. Local Points-110-002
4. Radar-210-001
5. Track-110-001
6. Hist_PLBK-650-001
7. SCDL Mgmt-420-001

Phase III was completed using the JDS07_004 build (based on the TADIL-J Upgrade build) and the aircraft and laboratory configuration as depicted in Figure 0-2.

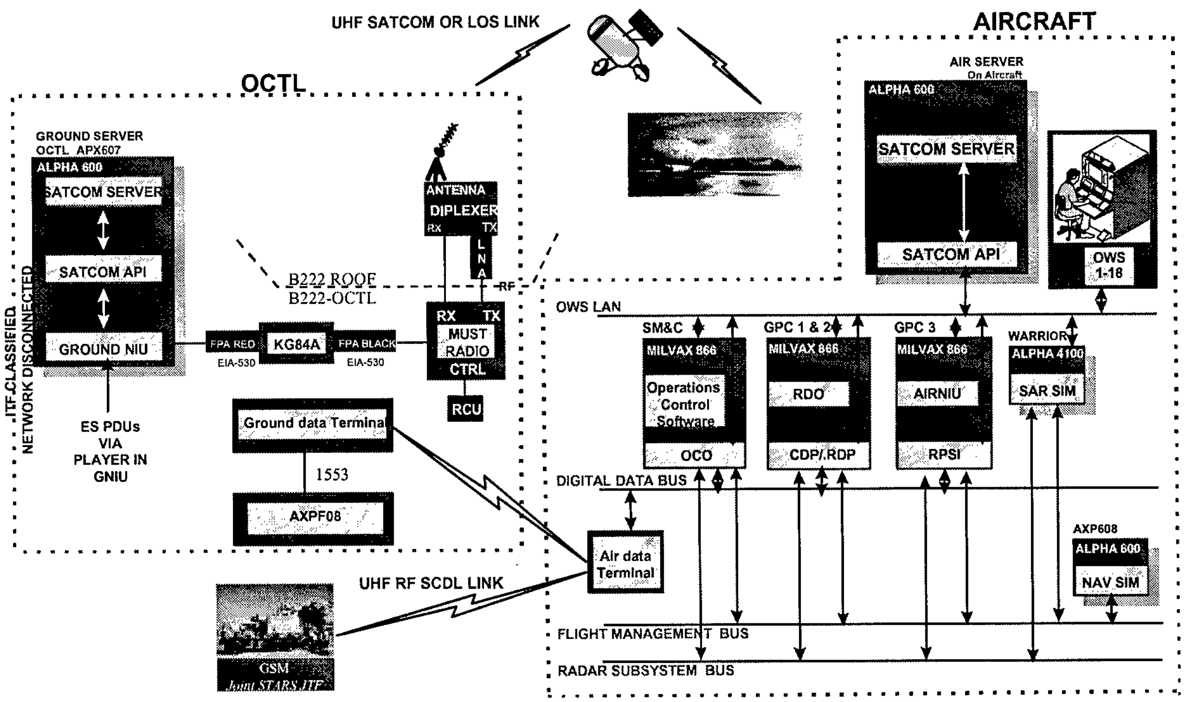

Figure 0-2. Phase III Laboratory and Aircraft Configuration

All tests on 23 Feb met acceptance criteria except for the ability of the Surveillance and Control Data Link (SCDL) to receive Radar Service Request (RSRs) in the correct geographical area. For this test, a geographic offset was applied to the aircraft position information transmitted via downlink to the Ground Station Module (GSM). This offset was applied to force the GSM cartographic picture to Iraq even though the E-8C was really flying over Ft. Hood, TX. However, when GSM operators sent requests to the aircraft, no offset was in place for uplink messages. This resulted in RSRs displayed in Iraq while the aircraft's display was focused on Ft. Hood coordinates.
To correct this anomaly, an offset was applied to uplink as well as downlink messages. This modification was incorporated into a new JADs build, JDS07_006. Both V&V and SIT tests were once again run on the aircraft on 13 March 1999.

During the SCDL SIT, the software modification was tested. Both uplink and downlink messages were received, and the RSRs were displayed in the proper location. It was noted during the test, however, that the SCDL process PW5SDM stopped and had to be restarted before downlink was received by the ground.

All of the SITs were successful with only minor discrepancies. However, during the V&V it was discovered that fixed (non-moving) targets were coming across the SATCOM link as moving targets. This caused minor discrepancies while running the tracking and history SITs. After the test, it was determined that a new build would not be created. A fix to the problem was created in a patch area and the modifications were tested extensively in the lab and on the aircraft during pre-flight.

The source of the problem was the size of the Protocol Data Unit (PDU). The original size of the PDU transmitted over SATCOM to the E-8C was 192 bits. During development, the PDU size was increased to 224 bits. The SATCOM link was designed to handle 192 bit messages so when the PDUs came into the SATCOM server with 224 bits, the SATCOM link could not accurately interpret the target data.

The SATCOM changes were tested during the pre-flight on 18 March 1999. The test was successful. All target data was accurately portrayed on the operator workstation (OWS). Also, during pre-flight testing, an observation was made that mix area SARs were displayed as live versus virtual. This required a modification in the size and location of the "mixed" area so that the ground would receive virtual SARs in areas where they would be shooting missiles.

Phase IV V&V

Phase IV V&V comprised three live flights. These flights were flown on 19, 25, and 31 March 1999. For the flight, an Iraqi scenario was sent from a JANUS workstation at White Sands Missile Range over a T-1 connection to the Ground Network Interface Unit (GNIU) located at the Integrated Test Facility (ITF) in Melbourne, FL. This target information was then transmitted over SATCOM to the aircraft's SATCOM server and then to the spare General Purpose Computer (GPC) for processing and display on the OWSs. Additionally, both the MTI and the SAR data were transmitted to a GSM located in Ft. Hood, TX. Targeting information was passed from the GSM to the ASE/ASAS intelligence cell also located at Ft. Hood. Targeting requests were passed on to virtual ATACMS at Ft. Sill, OK where virtual missiles launched on virtual targets. Phase IV End-to-End (ETE) composition is shown in Figure 0-3. The internal configuration of the E-8C and the OCTL remain as in figure 2-2.

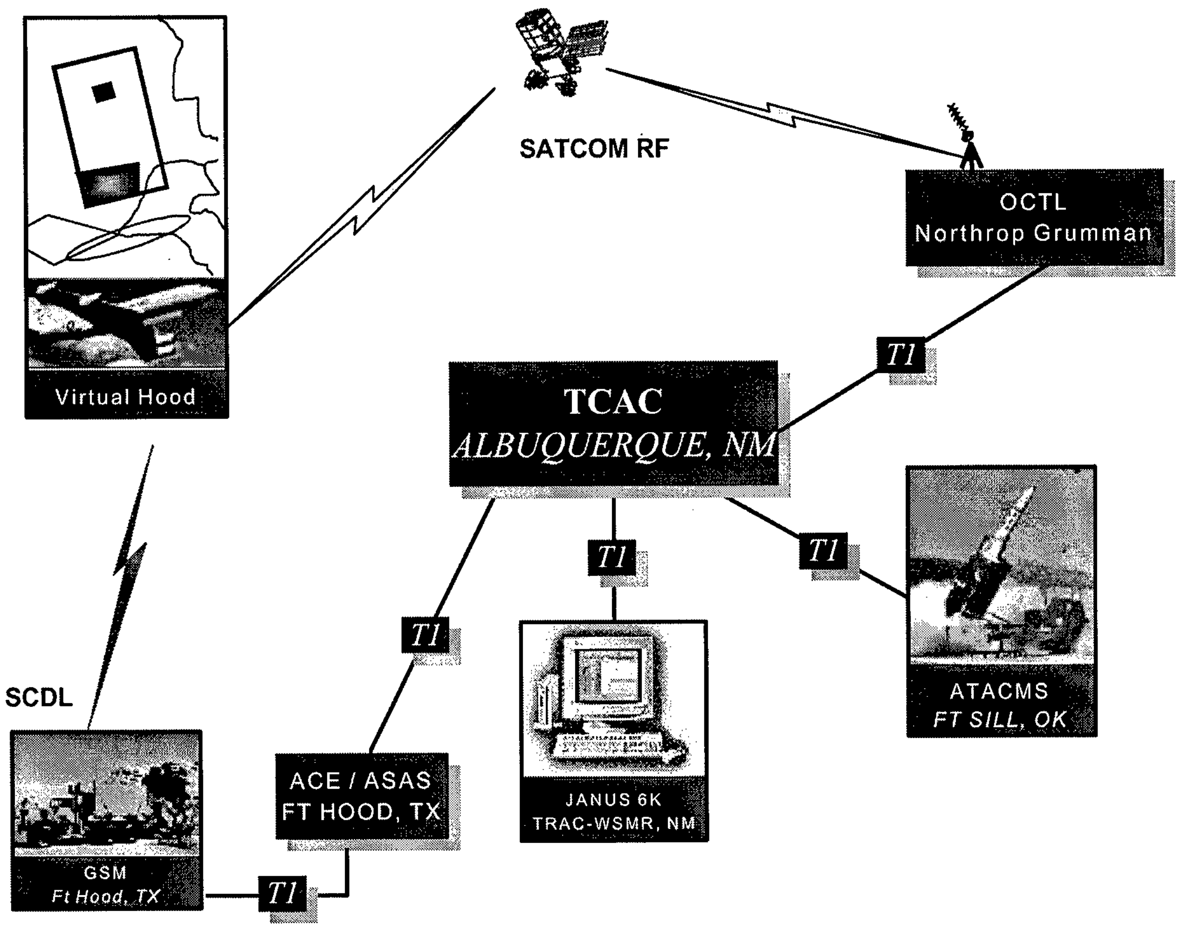

Figure 0-3. Phase IV ETE Composition

Northrop Grumman's (NG) role on these flights included operating and monitoring the simulation software. Also, testers ran a condensed version of previous V&V procedures to verify system operation functionality did not change while flying live missions. Joint STARS JTF test objective consisted of data collection and post flight analysis of radar data to verify that the simulation software did not have a negative impact in system performance. Test cards are included in Appendix B.

V&V included three scenario events. For the first event, only virtual data was displayed in the Ground Reference Coverage Area (GRCA). The second event required a virtual area in the northern portion of the GRCA with a live only area showing in the south western portion. The third event consisted of the same virtual and live area plus the addition of a mixed (live and virtual together) in the north-central area of the GRCA.

Live Flights

Flight 331-3, 19 March, 1999

Scenario Event One - Only virtual targets were displayed. Virtual targets included both moving and stationary ground vehicles. The displayed data were observed and evaluated for consistency relative to normal Joint STARS presentations. Due to problems with connecting to the SCDL, the virtual only data was not transmitted to the GSM.

Scenario Event Two - The live area was activated in addition to the virtual. Virtual vehicles continued to traverse the virtual area with live only vehicles displayed soon after

the live area was activated and MTI simulation was restarted. Scheduled live targets were instrumented for collection of Time Space Position Information (TSPI) truth data. The JTF will compare recorded radar data to the TSPI to accomplish the radar regression tests. Two-way SCDL link was operational for this test event, so the entire E-8C radar picture as well as free text messages were transmitted to the GSM.

Scenario Event Three - In addition the to the active virtual and live area, a mixed area was activated in the northern portion of the virtual area. Data was tracked and transmitted to the GSM. All radar data operated as expected.

Flight 333-3, 25 March, 1999

The objective of this flight was to increase support time to the ground forces to better evaluate the utility of the simulation software for operational training. The three scenarios from the previous mission were re-accomplished in the same configuration as the first flight.

The aircraft received scenario data via SATCOM from WSMR. Scenario events one and two were successful. Initially, SCDL transmission was delayed due to a GSM procedural error, but performed correctly once two-way SCDL was operational. Scenario three was not able to run, however, due to unknown system problems.

Flight 335-3, 31 March, 1999

The objective of this flight was to successfully run scenario event three, which included the virtual, live, and mixed areas. No radar regression testing was performed on this flight.

As on previous flights, WSMR transmitted virtual moving and stationary targets to the ITF at Northrop Grumman. The scenario data was then forwarded over SATCOM to the E-8C where it was processed with the "live" E-8C radar picture for mixed display on the OWS. Two-way SCDL link was established with the GSM located at Ft. Hood.

The data presented to the operators was seamless and provided realistic operational training. Both the virtual and the live radar pictures had good registration and performed well throughout the mission.

There was a minor delay getting the SCDL link operational because the SCDL downlink manager process, PW5SDM intermittently stopped and restarted. Neither of these problems impacted mission effectiveness.

V&V Results Summary

The results of the Phase 3 V&V of is presented in Table 0-1. The table lists both the V&V and SIT procedures that were tested as well as any anomalies.

Table 0-1 GROUND TEST VERIFICATION SUMMARY

TEST POINT	ANOMALIES	CORRECTIVE ACTION
1. MTI and SATCOM Verification		
• Demonstrate SATCOM transmission of ESPDU data onto the aircraft.	13 Mar: Non-moving PDUs came across the network as moving target indicator.	SATCOM software originally developed to handle 192 bits of data was modified to handle 234 bits of data.
• Verify that the simulation receives and integrates virtual data within the aircraft.	None	
• Verify that the simulation operates in three modes: live only, mixed live and virtual, and virtual only.	None	
2. SARSIM Validation		
• Verify that the simulation displays live (noise since the aircraft will not be radiating) SARs in live AOIs.	None	
• Verify that the simulation displays virtual SARs in mixed and virtual areas using a SATCOM scenario	23 Feb and 13 Mar: In mixed areas, SARs were displayed as live SARs instead of virtual.	Mixed area coordinates were relocated so that the live SARs would not interfere with ATACM shots based on virtual SAR data.
3. Order of Battle (OB)-110-003	Error received after requesting 7th OB area.	Operator went to a different OWS and was able to create all of the OB Areas.
4. Comm-310-001	13 Mar: The UHF radio tone enabled when the comm page was selected from a CDU and UHF radio selected.	Enabling the on radio button in the RADIO CNTRL STAT TD cleared the tone.
5. Local Points-110-002	Minor redlines to the procedure.	None Required
6. Radar-210-001	Minor redlines to the procedure.	None Required
7. Track-110-001	Minor redlines to the procedure. Also, on 13 Mar, the A-track would not track the data. This was due to the earlier problem of fixed targets showing up as movers.	Once only moving MTI was processed, the A-Track functionality worked as expected.
8. Hist_PLBK-650-001	Minor redlines to the procedure.	None Required

TEST POINT	ANOMALIES	CORRECTIVE ACTION
9. SCDL Mgmt-420-001	23 Feb: RSRs from both the GSM and the GDT in the OCTL were not displayed at the correct location on the E-8C graphics Display (GD) 13 Mar: Slow getting downlink established with the GSM due to the process PW5SDM auto-stopping.	Offset was added to incoming RSRs so that when requested, they were shown on the Iraq Carto with the Ft. Hood mission center. No fix was required because the process re-set itself.

Phase IV, flight tests, results are shown in Table 0-2 below.

Table 0-2. FLIGHT TEST VERIFICATION SUMMARY

TEST POINT	ANOMALIES	CORRECTIVE ACTION
1. MTI and SATCOM Verification		
• Demonstrate SATCOM transmission of ESPDU data onto the aircraft.	None	
• Verify that the simulation receives and integrates virtual data within the aircraft.	None	
• Verify that the simulation operates in three modes: live only, mixed live and virtual, and virtual only.	None	
2. SARSIM Validation		
• Verify that the simulation displays live (noise since the aircraft will not be radiating) SARs in live AOIs.	None	
• Verify that the simulation displays virtual SARs in mixed and virtual areas using a SATCOM scenario	Known anomaly - SARs were displayed as live SARs instead of virtual in the mixed area.	Mixed area coordinates were relocated so that the live SARs would not interfere with ATACM shots based on virtual SAR data.
3. Route Processing Functionality	None	None
4. E and A-Tracker Functionality	None	None
5. Engagement Point Functionality	None	None
6. History Playback Functionality	None	None
7. User Defined Activity Areas	None	None
8. Timeline Impact Tabular Display	None	None
9. Jammer Sectors	None	None
10. Area and Sector Blanking	None	None
11. Pull-Down Menu	None	None

Appendices A – C

intentionally removed

Requests for this document made before 1 March 2000 shall be referred to JADS JTF, 2050A 2nd Street SE, Kirtland Air Force Base, New Mexico, 87117-5522. After 1 March 2000, requests shall be referred to HQ AFOTEC/HO, 8500 Gibson Blvd. SE, Kirtland Air Force Base, New Mexico 87117-5558 or SAIC Technical Library, 2001 North Beauregard St. Suite 800, Alexandria, Virginia 22311.

APPENDIX D

SATCOM Performance Predictions

The predicted JADS SATCOM link margin while on orbit is 5 dB as shown in Figure 0-4. Based on the DM-34 antenna profile, an elevation angle of37° is 5 dB off from the rated 6 dbi gain. A bank of 20° during a turn will result on loss of link and of data for approximately 8% of the on orbit time. This reduces the PDU throughput from 33 to 30 PDUs/sec. Note this is for only one of the turns. The other turn will see an increased gain of 1.2 dB from the antenna. This is based on the antenna vendor profile and not from experimental data.

	PDUs stuffed into single SATCOM Packet (BPS)						
Polling Cycle Duration (s)	1 PDU	2 PDU	3 PDU	4 PDU	5 PDU	PDUs/sec	92% PDU Rate
20 (default)	9,927	11,942	12,661	13,169	13,493	33.2	30.5
60	11,510	13,847	14,681	15,270	15,645	38.5	35.4

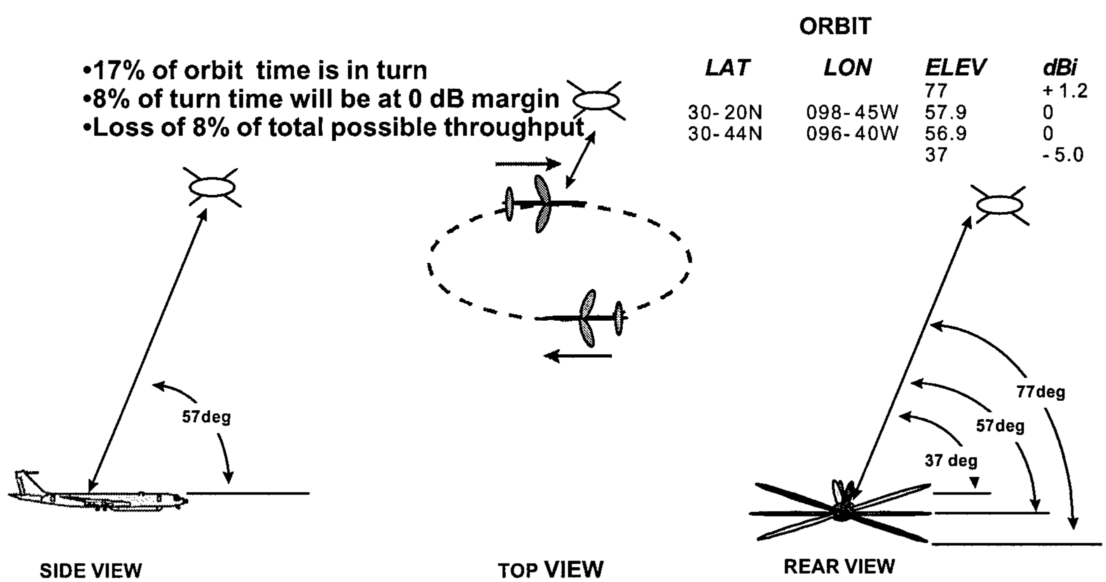

Figure 0-4. Predicted SATCOM Link Margin

Acronym List
ACRONYMS

ANIU	Air Network Interface Unit
AOI	Areas of Interest
ARIES	Advanced Radar Imaging Emulation System
CDRL	Contract Data Requirement List
DIS	Distributive Interactive Simulation
DRP	Data Reduction Program
ESPDU	Entity State Protocol Data Units
ETE	End-to-End
FTI	Fixed Target Indicator
FTISIM	Fixed Target Indicator Radar Simulation
GD	Graphics Display
GNIU	Ground Network Interface Unit
JADS	Joint Advanced Distributed Simulation
Joint STARS	Joint Surveillance Target Attack Radar System
JTF	Joint Test Force
MSGMON	Message Monitor
MTI	Moving Target Indicator
MTISIM	Moving Target Indicator Simulation
NAVSIM	Navigation Simulation
OCTL	Operation & Control Test Laboratory
PDU	Protocol Data Units

PSP	Programmable Signal Processor
PSPSIM	Programmable Signal Processor Simulation
RPSI	Radar Processor Simulation and Integrator
SAR	Synthetic Aperture Radar
SGI	Silicon Graphics Incorporated
STR	Software Trouble Report
TCS	Topocentric Coordinate System
TSPI	Time-Space Position Information
V&V	Validation and Verification

Appendix B

Joint STARS Flight Test Cards

JSTARS FLIGHT TEST RECORD

A/C ID: E-8C **FLIGHT NUMBER:** 335-3 **Flight Card #** 12

MISSION: JADS	VERSION DATE: 24 Mar 99

JADS test cards

JSTARS FLIGHT TEST RECORD

A/C ID: E-8C **FLIGHT NUMBER:** 335-3 **Flight Card #** 13

MISSION: JADS	VERSION DATE: 24 Mar 99

STEP	POSITION	PROCEDURE		*TIME/CHECK
1.	TCO	Ensure the following messages are selected for recording on **GPC 2**		
		MC20 SAR_Parameters_MSG_XD	AII10_RADAR	
		MC21 MTI_Parameters_MSG_XD	AII10_RADAR	
		MC21 MTI_PARAM_RPT_SS_LOW_RES	PSP NODE MSGS	
		MC21 MTI_PARAM_RPT_WAS_GRCA	PSP NODE MSGS	
		MC21 MTI_PARAM_RPT_WAS_RRCA	PSP NODE MSGS	
		MC21 MTI_PARAM_RPT_SS_MED_RES	PSP NODE MSGS	
		MC21 MTI_PARAM_RPT_AC_MTI	PSP NODE MSGS	
		MC21 MTI_PARAM_RPT_AP	PSP NODE MSGS	
		MC21 MTI_PARAM_RPT_SATC	PSP NODE MSGS	
		MC44 Target_Indicator_RD	FLT_TEST	
		MC42 SAR_Report_RD	FLT_TEST	
		MWN5 NAV_Sensor_Data_Msgs_ND	FLT_TEST	
		MALI STANDARD_SR_MSG_VQ	FLT_TEST	
		MC85 PRIMARY_MODE_CTRL_XQ	FLT_TEST	
		MC24 AUX_DATA_RD	AII10_RADAR	
2.	TCO	Ensure the following messages are selected for recording on **GPC 3**		
		MC21 MTI_Parameters_MSG_XD	AII10_RADAR	
		MC21 MTI_PARAM_RPT_SS_LOW_RES	PSP NODE MSGS	
		MC21 MTI_PARAM_RPT_WAS_GRCA	PSP NODE MSGS	
		MC21 MTI_PARAM_RPT_WAS_RRCA	PSP NODE MSGS	
		MC21 MTI_PARAM_RPT_SS_MED_RES	PSP NODE MSGS	
		MC21 MTI_PARAM_RPT_AC_MTI	PSP NODE MSGS	
		MC21 MTI_PARAM_RPT_AP	PSP NODE MSGS	
		MC21 MTI_PARAM_RPT_SATC	PSP NODE MSGS	
		MC44 Target_Indicator_RD	FLT_TEST	
		MWN5 NAV_Sensor_Data_Msgs_ND	FLT_TEST	
		MALI STANDARD_SR_MSG_VQ	FLT_TEST	
		MC85 PRIMARY_MODE_CTRL_XQ	FLT_TEST	
		MC24 AUX_DATA_RD	AII10_RADAR	
3.	VSTARS	Verify in **DUA0:[CMSDSK.JDS07_006_SECRET.RUNTIME]** that the **JADS_LIVE_AOI.DAT** file is set to **0** live areas.		

Orbit: The test orbit, Hood 2, is south of Ft Hood, located below Killeen, TX. The orbit end points are: 30 20'N 98 45'W and 30 44'N 96 40'W

Test Range: Ft Hood, TX

General: Ft Hood Training Areas have topographical features representative of rolling hills, forested areas, and cleared flat areas.

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JSTARS FLIGHT TEST RECORD

A/C ID: E-8C **FLIGHT NUMBER:** 335-3 **Flight Card #** 14

MISSION: JADS	VERSION DATE: 24 Mar 99

Topography: Rolling hills, cleared flat areas, and forested areas. The majority of terrain is level with slopes below five percent.

Vegetation: Mostly sagebrush with small trees, and grassy areas.

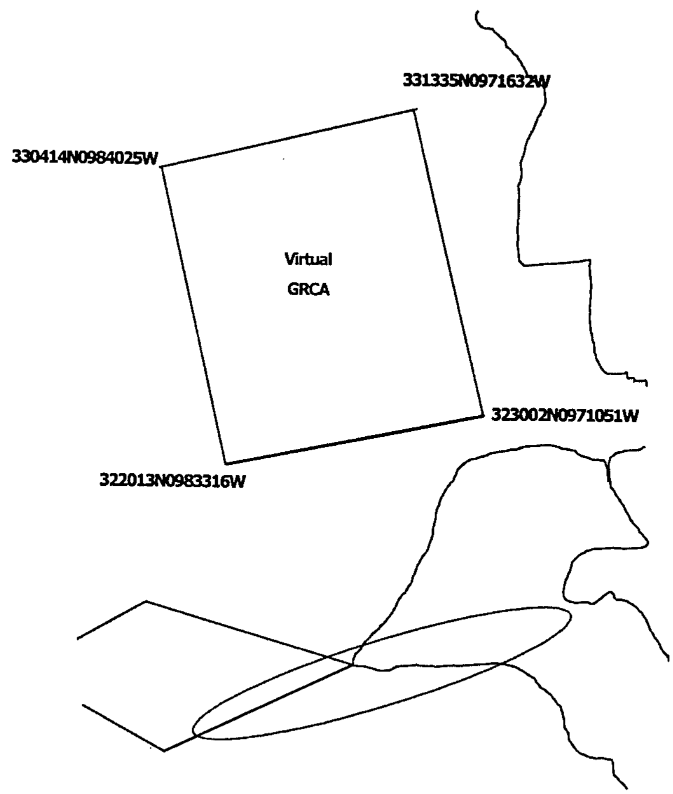
Road: Numerous secondary roads leading in and out of training areas. Edges of training areas are surrounded with primary roads. Contour of both road types is generally level. Secondary roads are sparsely used except during major training exercises.

JSTARS FLIGHT TEST RECORD

A/C ID: E-8C **FLIGHT NUMBER: 335-3** **Flight Card # 15**

MISSION: JADS	VERSION DATE: 24 Mar 99

Scenario Load Phase VSTARS operators will initialize the VSTARS processes. Distribute Interactive Simulation (DIS) packets are transmitted from White Sands Missile Range, NM to the NG lab via a T-1 line. These packets are transformed by the ground network interface unit (GNIU) and via SATCOM are transmitted to the air network interface unit (ANIU) onboard T-3. The loading phase will run for 30 minutes in this configuration.



JSTARS FLIGHT TEST RECORD

A/C ID: E-8C **FLIGHT NUMBER:** 335-3 **Flight Card #** 16

MISSION: JADS	**VERSION DATE: 24 Mar 99**

OBJECTIVES:	**AOI/ASSETS**	**TEST POINT COMPLETION CRITERIA:**
1) Complete End-To-End (ETE) connectivity. - GSM (Ft. Hood) - Ground Network Interface Unit (GNIIU) - Test Control Analysis Center (TCAC) - T3 Connectivity 2) Conduct V&V functionality checks of VSTARS.	**AOI:** 330414N0984025W (UL) 331335N0971632W (UR) 323002N0971051W (LR) 322013N0983316W (LL) (Virtual Only) **ASSETS:** None scheduled for virtual portion of flight.	1) Run with virtual only data in the AOI for the first 1/3 of SATCOM time minus the 30 min load. 2) Two way SCDL will be available for the run. 3) SATCOM link and successful PDU receipt by aircraft.
ALTITUDE: 35,000 ft.	**ORBIT:** Hood 2	**SPEED:** Spec

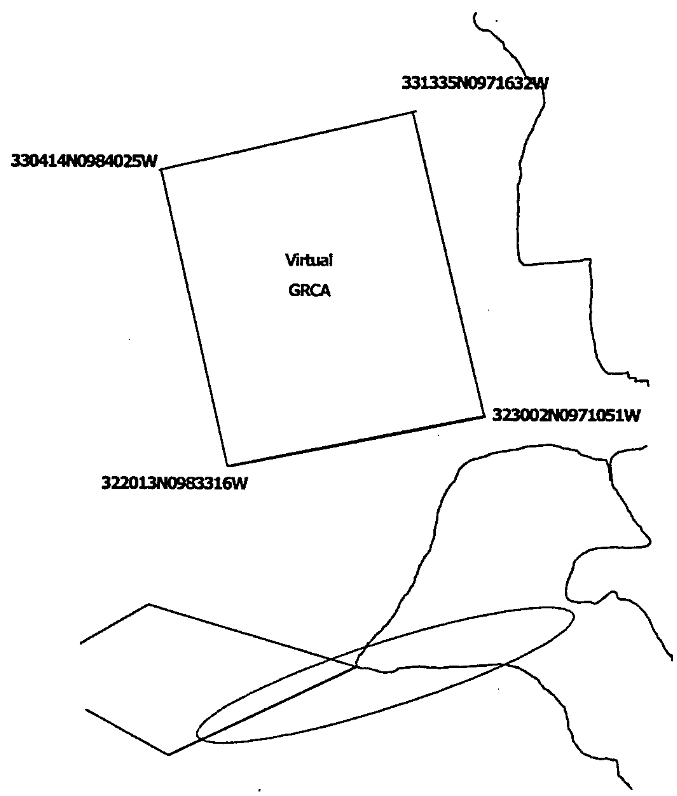
STEP	POSITION	PROCEDURE	*TIME/CHECK
1.	VSTARS	Request a GRCA using the above AOI coordinates.	
2.	RMO	Approve GRCA	
3.	VSTARS	Verify in **DUA0:[CMSDSK.JDS07_006_SECRET.RUNTIME]** that the **JADS_LIVE_AOI.DAT** file is set to **0** live areas.	
4.	VSTARS	About 15 min prior to being ready for PDUs, call COMM and request a "phone patch" to WSMR at the following phone number: **(505) 678-5247**	
5.	VSTARS	Bring up VSTARS processes **(See Appendix)** MTISIM SARSIM SCDL Offset SATCOM DISNIU	
6.	VSTARS	In DISNIU, set log mode to 7	

JSTARS FLIGHT TEST RECORD

A/C ID: E-8C **FLIGHT NUMBER:** 335-3 **Flight Card #** 17

MISSION: JADS	VERSION DATE: 24 Mar 99

Scenario #1 The operator workstation (OWS) will display cartographic and hypsographic data from Southeast Iraq with mission center as Ft Hood test range. Both live and mixed areas are turned off permitting virtual only areas throughout the AOI. Distribute Interactive Simulation (DIS) packets are transmitted from White Sands Missile Range, NM to the NG lab via a T-1 line. These packets are transformed by the ground network interface unit (GNIU) and via SATCOM are transmitted to the air network interface unit (ANIU) onboard T-3. These packets are represented on the OWS as virtual targets. The AOI coordinates are included in the test procedures. The scenario will run for 1/3rd of the SATCOM time in this configuration. VSTARS representatives will perform available operator functions on a non-interference basis. During this time onboard ATSS will coordinate with GSM operators concerning the SCDL link and RSR request. Operators will request normal radar scans of the "virtual GRCA"



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JSTARS FLIGHT TEST RECORD

A/C ID: E-8C **FLIGHT NUMBER:** 335-3 **Flight Card #** 18

MISSION: JADS	VERSION DATE: 24 Mar 99

OBJECTIVES:	AOI/ASSETS	TEST POINT COMPLETION CRITERIA:
1) Complete End-To-End (ETE) connectivity. - GSM (Ft. Hood) - Ground Network Interface Unit (GNIIU) - Test Control Analysis Center (TCAC) - T3 Connectivity 2) Conduct V&V functionality checks of VSTARS.	**AOI:** 330414N0984025W (UL) 331335N0971632W (UR) 323002N0971051W (LR) 322013N0983316W (LL) (Virtual Only) **ASSETS:** None scheduled for virtual portion of flight.	1) Run with virtual only data in the AOI for the first 1/3 of SATCOM time minus the 30 min load. 2) Two way SCDL will be available for the run. 3) SATCOM link and successful PDU receipt by aircraft.
ALTITUDE: 35,000 ft.	**ORBIT:** Hood 2	**SPEED:** Spec

STEP	POSITION	PROCEDURE	*TIME/CHECK
1.	VSTARS	Confirm that the scenario is running in the DISMON and on the GD	
2.	VSTARS	Verify that only virtual targets are displayed on the GD	
3.	VSTARS	Request a FTI at **320142N0974958W** over fixed targets.	
4.	VSTARS	Request a SAR over the airstrip.	
5.	VSTARS	Request a SAR over moving targets.	
6.	VSTARS	Build a route along a road with a convoy on it.	
7.	VSTARS	On a non-interference basis, request an AC area over a target group.	
8.	VSTARS	Establish a constrained A-track over convoy and select AC for auto-repositioning.	
9.	VSTARS	Build an EP in front of the A-Track and pair it to the track.	
10.	VSTARS	Delete the pairing and the EP	
11.	VSTARS	Build an arbitrary route	
12.	VSTARS	Delete the arbitrary route from the route list TD	
13.	VSTARS	Initiate an E-track over an off-road convoy.	
14.	VSTARS	Open the history playback window and display history in the various available modes.	

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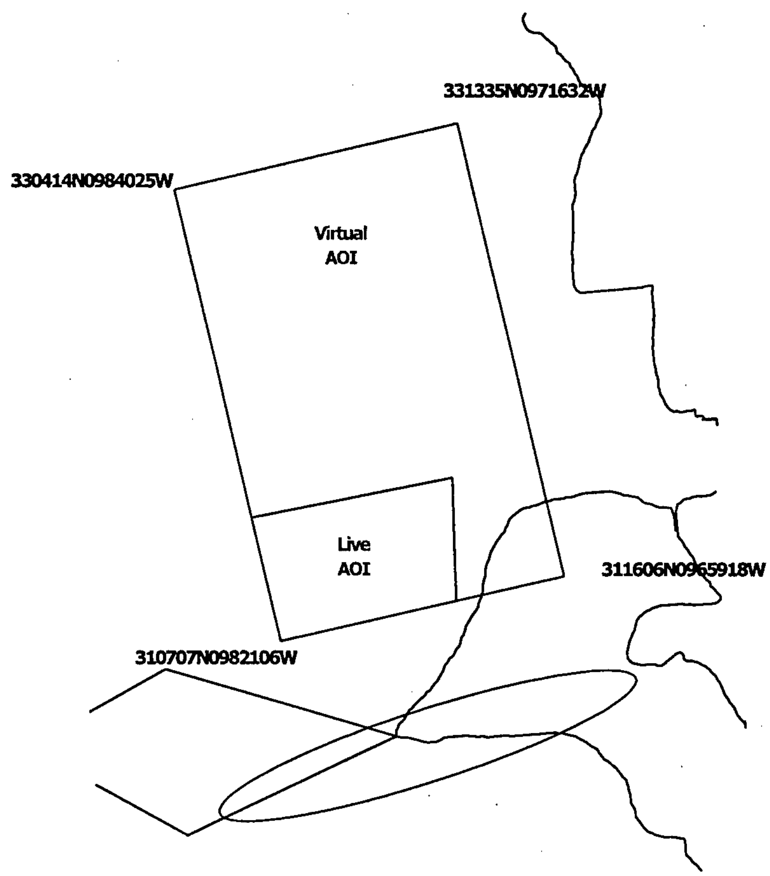
JSTARS FLIGHT TEST RECORD

A/C ID: E-8C **FLIGHT NUMBER:** 335-3 **Flight Card #** 19

MISSION: JADS	VERSION DATE: 24 Mar 99

Scenario #2 - The operator workstation (OWS) will display cartographic and hypsographic data from Southeast Iraq with mission center as Ft Hood test range. The live area is turned on while the mixed areas remain off. This will permit virtual only areas in the upper portion of the GRCA and live only in the lower portion. The AOI coordinates are included in the test procedures. The scenario will run for 1/3rd of the SATCOM time in this configuration. VSTARS representatives will request various types of RSRs on a non-interference basis. During this time onboard ATSS will coordinate with GSM operators concerning the SCDL link and RSR request.. Operators will request normal radar scans of the GRCA.



JSTARS FLIGHT TEST RECORD

A/C ID: E-8C **FLIGHT NUMBER:** 335-3 **Flight Card #** 20

MISSION: JADS	**VERSION DATE: 24 Mar 99**

OBJECTIVES:	**AOI/ASSETS**	**TEST POINT COMPLETION CRITERIA:**
1) Complete End-To-End (ETE) connectivity. - GSM (Ft. Hood) - Ground Network Interface Unit (GNIIU) - Test Control Analysis Center (TCAC) - T3 Connectivity 2) Conduct V&V functionality checks of VSTARS.	**AOI:** 330414N0984025W (UL) 331335N0971632W (UR) 311606N0965918W (LR) 310707N0982106W (LL) **ASSETS:** Live Ft. Hood assets scheduled.	1) Run with virtual only data in the AOI for the first 1/3 of SATCOM time minus the 30 min load. 2) Two way SCDL will be available for the run. 3) SATCOM link and successful PDU receipt by aircraft.
ALTITUDE: 35,000 ft.	**ORBIT:** Ft. Hood 2	**SPEED:** Spec

STEP	POSITION	PROCEDURE	*TIME/CHECK
1.	VSTARS	Request a GRCA modification to match the AOI coordinates above	
2.	RMO	Approve GRCA modification	
3.	VSTARS	Turn off MTI SIMULATION	
4.	VSTARS	Open **DUA0:[CMSDSK.JDS07_006_SECRET.RUNTIME]JADS_LIVE_AOI.DAT** file and set live areas to **1** to activate the live area.	
5.	VSTARS	Turn MTI simulation back on.	
6.	VSTARS	Request a "live" SAR at the following coordinates: **31194N0974100W**	
7.	VSTARS	Perform radar screening using all available options.	
8.	VSTARS	Create a default **UDA**. *Select coordinates* that are *5 km* from in front of targets route of travel. Change the **threshold number** to **5**.	
9.	VSTARS	Perform a Timeline Impact for all RSR except the pending RRCA	
10.	VSTARS	Initiate a SBSR area. Verify that that the targets in the sector are blanked.	
11.	VSTARS	Delete the SBSR area.	
12.	VSTARS	Initiate an ABSR area. Verify that targets in the area are blanked.	
13.	VSTARS	Delete the ABSR.	

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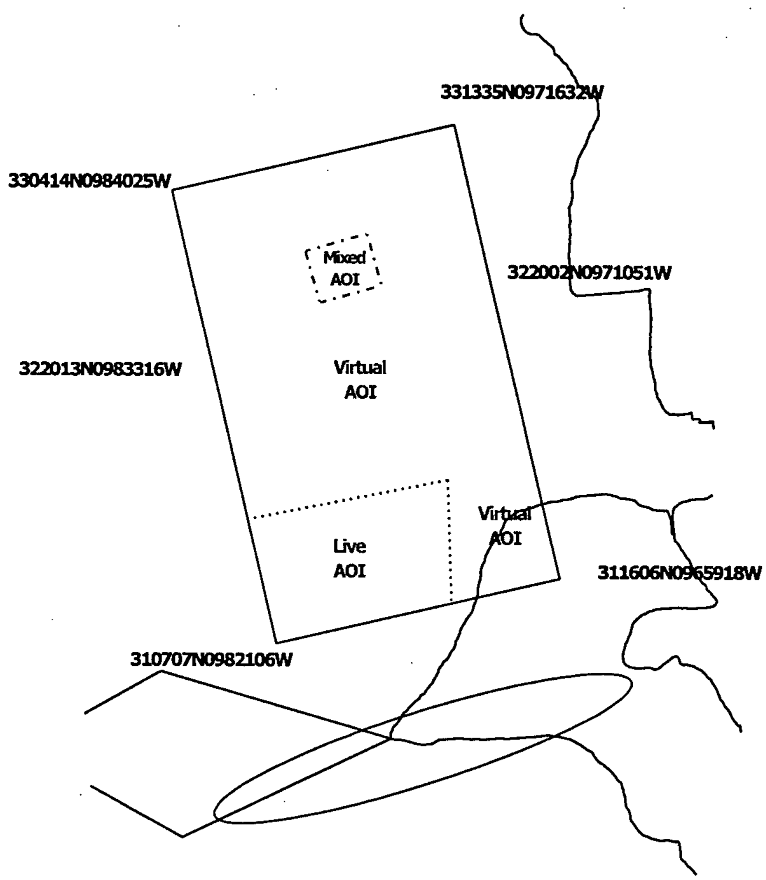
JSTARS FLIGHT TEST RECORD

A/C ID: E-8C **FLIGHT NUMBER:** 335-3 **Flight Card #** 21

MISSION: JADS	**VERSION DATE: 24 Mar 99**

Scenario #3 - The operator workstation (OWS) will display cartographic and hypsographic data from Southeast Iraq with mission center as Ft Hood test range. The live area is and the mixed areas are activated. This will permit mixed areas in the upper portion of the GRCA and live only in the lower portion. The AOI coordinates are included in the test procedures. The scenario will run for 1/3rd of the SATCOM time in this configuration. VSTARS representatives will request various types of RSRs on a non-interference basis. During this time onboard ATSS will coordinate with GSM operators concerning the SCDL link and RSR request. . Operators will request normal radar scans of the GRCA.



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JSTARS FLIGHT TEST RECORD

A/C ID: E-8C **FLIGHT NUMBER:** 335-3 **Flight Card #** 22

MISSION: JADS	**VERSION DATE: 24 Mar 99**

OBJECTIVES:	**AOI/ASSETS**	**TEST POINT COMPLETION CRITERIA:**
1) Complete End-To-End (ETE) connectivity. - GSM (Ft. Hood) - Ground Network Interface Unit (GNIIU) - Test Control Analysis Center (TCAC) - T3 Connectivity 2) Conduct V&V functionality checks of VSTARS.	**AOI:** 330414N0984025W (UL) 331335N0971632W (UR) 311606N0965918W (LR) 310707N0982106W (LL) **ASSETS:** Live Ft. Hood assets scheduled.	1) Run with virtual only data in the AOI for the first 1/3 of SATCOM time minus the 30 min load. 2) Two way SCDL will be available for the run. 3) SATCOM link and successful PDU receipt by aircraft.
ALTITUDE: 35,000 ft.	**ORBIT:** Ft. Hood 2	**SPEED:** Spec

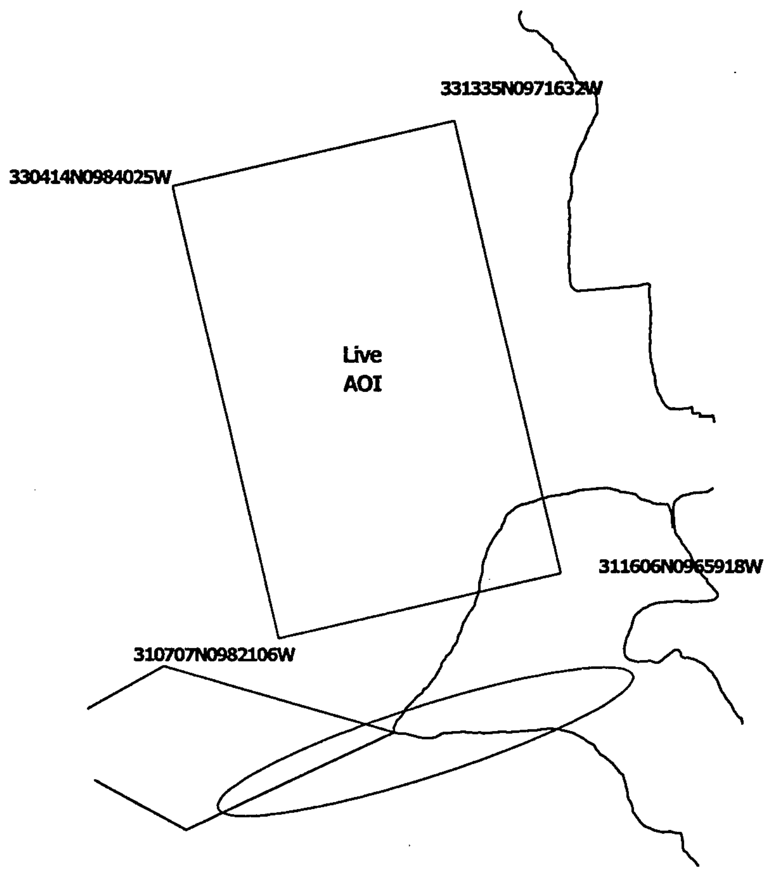
STEP	POSITION	PROCEDURE	*TIME/CHECK
1.	VSTARS	Turn off MTI SIMULATION	
2.	VSTARS	Open **DUA0:[CMSDSK.JDS07_006_SECRET.RUNTIME]JADS_LIVE_AOI.DAT** file and input the new mixed area coordinates: **324349N0980330W 60160 -898 -277** **324531N0974655W 86016 2438 -573** **323220N0974357W 90880 -21882 -680** **323005N0975940W 66300 -26234 -396** When finished set live areas to **2** to activate the live and mixed area.	
3.	VSTARS	Turn MTI simulation back on.	
4.	VSTARS	Demonstrate all functions available from the pull-down menu.	
5.	VSTARS	Request an AC area over a group of targets.	
6.	VSTARS	Initiate an A-Track on the targets and auto reposition the AC.	
7.	VSTARS	Let the track run for 10 min then deleted the track and the AC.;	

JSTARS FLIGHT TEST RECORD

A/C ID: E-8C **FLIGHT NUMBER:** 335-3 **Flight Card #** 23

MISSION: JADS	VERSION DATE: 24 Mar 99

Scenario #4 - The operator workstation (OWS) will display cartographic and hypsographic data from Southeast Iraq with mission center as Ft Hood test range. MTI simulation will be turned off in order to characterize aircraft radar performance in the area. The AOI coordinates are included in the test procedures. The scenario will run in this configuration until the JTF has enough data for reduction. Operators will request radar scans of the GRCA based on their test cards.



JSTARS FLIGHT TEST RECORD

A/C ID: E-8C **FLIGHT NUMBER:** 335-3 **Flight Card #** 24

MISSION: JADS	VERSION DATE: 24 Mar 99

OBJECTIVES:	AOI/ASSETS	TEST POINT COMPLETION CRITERIA:
1) Data collection for JTF	**AOI:** 330414N0984025W (UL) 331335N0971632W (UR) 311606N0965918W (LR) 310707N0982106W (LL) **ASSETS:** Live Ft. Hood assets scheduled.	1) Time remaining run with live data in the AOI.
ALTITUDE: 35,000 ft.	**ORBIT: ORBIT:** Ft. Hood 2	**SPEED:** Spec

STEP	POSITION	PROCEDURE	*TIME/CHECK
1.	VSTARS	Turn off MTI SIMULATION so system can run live only.	
2.	VSTARS	Use VSTARS attached procedures to begin shutdown of the JADS processes.	
3.	VSTARS	Ask the ART to put the following files on the copyman disk: **user$disk:[mission.secret_satcom.data.flt_*fltnumber*]** **jstars_log:[cair_test903d.log]**	

Appendix C

Apparent VDP Losses

3/19/99	3/19/99	3/19/99	3/31/99	3/31/99	3/31/99
num_lost	log_msecs	log_hms	num_lost	log_msecs	log_hms
1	63611994	17:40:11	75	58331358	16:12:11
2	65986960	18:19:46	1	58425881	16:13:45
2	66009042	18:20:09	5	58426849	16:13:46
2	66044965	18:20:44	27	58426866	16:13:46
2	66068001	18:21:08	117	58428860	16:13:48
2	66105084	18:21:45	1	58429919	16:13:49
2	66128014	18:22:08	1	58545893	16:15:45
2	66187012	18:23:07	227	58576513	16:16:16
52	66212995	18:23:32	1	58584835	16:16:24
91	66227012	18:23:47	2	58665872	16:17:45
2	66251326	18:24:11	2	58684842	16:18:04
2	66310145	18:25:10	2	58726025	16:18:46
32	66332090	18:25:32	2	58744840	16:19:04
2	66369037	18:26:09	2	58785863	16:19:45
1	66373052	18:26:13	2	58804876	16:20:04
174	66384077	18:26:24	2	58845883	16:20:45
173	66405021	18:26:45	2	58864853	16:21:04
2	66429136	18:27:09	2	58905869	16:21:45
683	66449156	18:27:29	2	58924854	16:22:04
2	66528143	18:28:48	2	58965861	16:22:45
2	66547216	18:29:07	2	59000997	16:23:20
2	66588164	18:29:48	2	59059004	16:24:19
2	66606177	18:30:06	2	59117210	16:25:17
2	66627183	18:30:27	2	59184916	16:26:24
4	67513309	18:45:13	2	59242932	16:27:22
1	67728327	18:48:48	2	59301041	16:28:21
1	68804439	19:06:44	2	59359050	16:29:19
1	68865533	19:07:45	2	59417211	16:30:17
1	68954411	19:09:14	3	59484959	16:31:24
1	68954419	19:09:14	3	59685859	16:34:45
1	69012507	19:10:12	279	59746862	16:35:46
1	69012512	19:10:12	1	59755999	16:35:55
1	69101477	19:11:41	58	59771899	16:36:11
1	69162829	19:12:42	7	59775401	16:36:15
115	69257733	19:14:17	850	59779866	16:36:19
154	69278718	19:14:38	3	59985883	16:39:45
47	69335721	19:15:35	677	60241315	16:44:01
180	69394715	19:16:34	11	60249574	16:44:09
1	69525474	19:18:45	60	60390241	16:46:30
2	69583793	19:19:43	1	60394768	16:46:34
2	69611811	19:20:11	133	60406248	16:46:46

3/19/99	3/19/99	3/19/99	3/31/99	3/31/99	3/31/99
num_lost	log_msecs	log_hms	num_lost	log_msecs	log_hms
2	69645788	19:20:45	2	60414100	16:46:54
2	69672817	19:21:12	103	60565310	16:49:25
2	69731849	19:22:11	2	60568921	16:49:28
2	69768570	19:22:48	113	60966914	16:56:06
2	69789563	19:23:09	1	60975573	16:56:15
2	69849610	19:24:09	1	61780565	17:09:40
1	69888635	19:24:48	1	61899558	17:11:39
2	69907706	19:25:07	1	62138585	17:15:38
2	69948611	19:25:48	1	62257631	17:17:37
2	69968619	19:26:08	1	62257642	17:17:37
1	70008647	19:26:48	1	62288622	17:18:08
2	70026674	19:27:06	1	62316604	17:18:36
2	70067675	19:27:47	90	62361736	17:19:21
2	70088070	19:28:08	1	62369177	17:19:29
1	70106564	19:28:26	81	62406436	17:20:06
1	70106569	19:28:26	2	62407882	17:20:07
2	70127710	19:28:47	1	62437262	17:20:37
2	70147702	19:29:07	2	62496576	17:21:36
2	70187612	19:29:47	106	62544763	17:22:24
2	70206596	19:30:06	1	62553103	17:22:33
2	70247642	19:30:47	106	62602695	17:23:22
2	70265681	19:31:05	1	62611210	17:23:31
1	70286866	19:31:26	2	62679705	17:24:39
2	62800562	17:26:40			
2	62860560	17:27:40			
2	62920562	17:28:40			
2	62980593	17:29:40			
2	63040599	17:30:40			
2	63160614	17:32:40			
2	63219718	17:33:39			
2	63279664	17:34:39			
1	63849893	17:44:09			
1	64120023	17:48:40			
191	64610759	17:56:50			
3	64614702	17:56:54			
75	65275071	18:07:55			
85	65465678	18:11:05			
2	65466498	18:11:06			
122	65544657	18:12:24			
4	65563240	18:12:43			
74	65589763	18:13:09			
1	65613747	18:13:33			
1	65800444	18:16:40			

3/31/1999 Cont	3/31/1999 Cont	3/31/1999 Cont
num_lost	log_msecs	log_hms
1	65860678	18:17:40
1	66040483	18:20:40
1	66159894	18:22:39
1	66218584	18:23:38
80	66278447	18:24:38
2	66279445	18:24:39
38	66309399	18:25:09
1	66318151	18:25:18
2	66338381	18:25:38
6	66349333	18:25:49
3	66353291	18:25:53
2	66398400	18:26:38
14	66436376	18:27:16
2	66436467	18:27:16
4	66436470	18:27:16
7	66437402	18:27:17
1	66438339	18:27:18
1	66446348	18:27:26
1	66447350	18:27:27
2	66448416	18:27:28
3	66448435	18:27:28
3	66448442	18:27:28
1	66451342	18:27:31
1	66451350	18:27:31
2	66457357	18:27:37
119	66472325	18:27:52
1	66472973	18:27:52
2	66516772	18:28:36
2	66576267	18:29:36
60	66610202	18:30:10
2	66618191	18:30:18
5	66626272	18:30:26
3	66627220	18:30:27
7	66629314	18:30:29
4	66633246	18:30:33
2	66634291	18:30:34
3	66635198	18:30:35
2	66636200	18:30:36
8	66636213	18:30:36
2	66637196	18:30:37
4	66654352	18:30:54
2	66656188	18:30:56
4	66662226	18:31:02

3/31/1999 Cont	3/31/1999 Cont	3/31/1999 Cont
num_lost	log_msecs	log_hms
5	66664280	18:31:04
2	66666239	18:31:06
2	66666248	18:31:06
1	66666259	18:31:06
3	66666270	18:31:06
6	66666300	18:31:06
1	66666328	18:31:06
3	66666350	18:31:06
2	66696282	18:31:36
2	66756274	18:32:36
1	66756283	18:32:36
2	66816227	18:33:36
2	66875257	18:34:35
2	66934232	18:35:34
1	66994221	18:36:34
1	66995719	18:36:35
2	67054151	18:37:34
2	67113139	18:38:33
2	67180180	18:39:40
3	67420127	18:43:40
73	68185100	18:56:25
2	68186205	18:56:26
94	68256105	18:57:36
2	68263625	18:57:43
59	68335125	18:58:55
1	68341036	18:59:01
1	68500084	19:01:40
43	68514057	19:01:54
2	68515261	19:01:55
1	68708788	19:05:08
14	68709689	19:05:09
15	69173611	19:12:53
1	69220778	19:13:40
1	69518587	19:18:38
2	69572644	19:19:32
1	69578631	19:19:38
1	69756597	19:22:36
1	69814519	19:23:34
1	69935726	19:25:35
1	70120108	19:28:40
2	70180461	19:29:40
2	70240349	19:30:40
2	70300549	19:31:40

3/31/1999 Cont	3/31/1999 Cont	3/31/1999 Cont
num_lost	log_msecs	log_hms
2	70360518	19:32:40
2	70420646	19:33:40
2	70479808	19:34:39
2	70539404	19:35:39
2	70598492	19:36:38
2	70658440	19:37:38
2	70718383	19:38:38
2	70777333	19:39:37
2	70836338	19:40:36
2	70900310	19:41:40
4691	70959295	19:42:39
113	70962012	19:42:42

Appendix D

Joint Advanced Distributed Simulation
End-to-End Test Report
of the
Joint Surveillance Target Attack Radar System (U)

JSTARS-E8C-TR-99-03

16 July 1999

Confidential appendix intentionally removed

Request copies from:

For Department of Defense : Joint STARS Joint Test Force, Melbourne, Florida

Other requests: HQ ESC/JS
75 Vandenberg Drive
Hanscom Air Force Base MA 01731-3128

Appendix E
Acronyms and Definitions

ADS	advanced distributed simulation
AFATDS	Advanced Field Artillery Tactical Data System
AFB	Air Force base
ANIU	air network interface unit
ATACMS	Army Tactical Missile System
ATWS	Advanced Technology Work Station
Bn	battalion
CEP	circular error probability
CGS	common ground station
DIS	distributed interactive simulation
DT	developmental test
ESPDU	entity state protocol data unit
ETE	End-to-End Test
GNIU	ground network interface unit
GPC	general purpose computer
GSM	ground station module
IEEE	Institute of Electrical and Electronics Engineers
JADS	Joint Advanced Distributed Simulation, Albuquerque, New Mexico
Janus	interactive, computer-based simulation of combat operations
Joint STARS	Joint Surveillance Target Attack Radar System
JTF	joint test force
LAN	local area network
LGSM	light ground station module
M&S	modeling and simulation
MGSM	medium ground station module
MTI	moving target indicator
O&C	operations and control
OT	operational test
P_D	probability of detection
PDU	protocol data unit
P_{fr}	probability of false alarm
RF	radio frequency
RPSI	radar processor simulator and integrator
SAR	synthetic aperture radar
SATCOM	satellite communications
SCDL	surveillance control data link
SE	synthetic environment
sec	second
SIT	system integration test
SME	subject matter expert
STRICOM	U.S. Army Simulation, Training, and Instrumentation Command
SUT	system under test

T-1	digital carrier used to transmit a formatted digital signal at 1.544 megabits per second
TAC	target analysis cell
TCAC	Test Control and Analysis Center, Albuquerque, New Mexico
TRAC	U.S. Army Training and Doctrine Command (TRADOC) Analysis Center
V&V	verification and validation
VDP	VSTARS data packet
VSTARS	Virtual Surveillance Target Attack Radar System
VV&A	verification, validation, and accreditation
WSMR	White Sands Missile Range